

WELLS AND SPRINGS OF LEICESTERSHIRE



DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH  
GEOLOGICAL SURVEY OF GREAT BRITAIN

**WELLS AND SPRINGS  
OF  
LEICESTERSHIRE**

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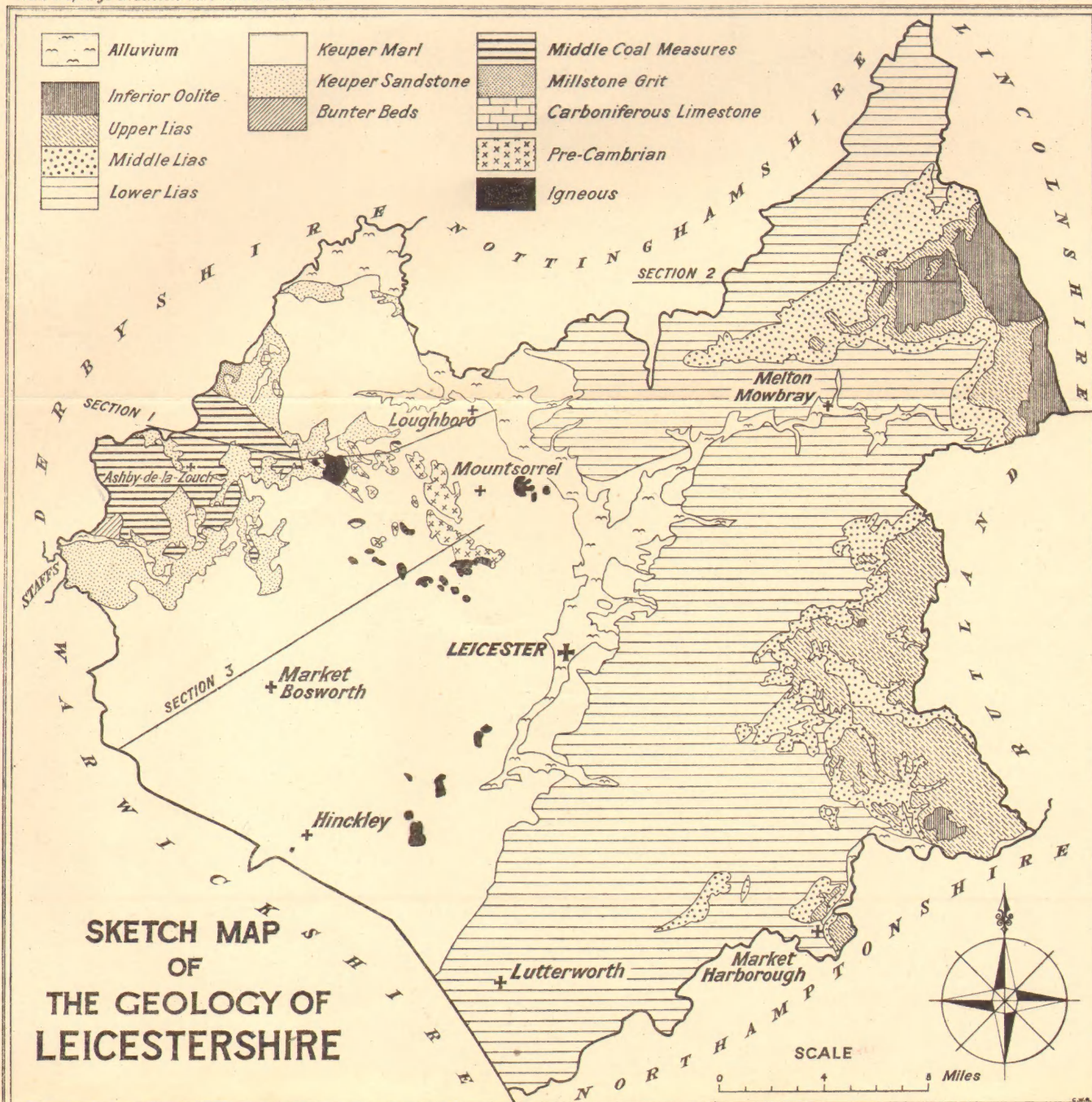
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DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL  
RESEARCH

MEMOIRS OF THE GEOLOGICAL SURVEY  
ENGLAND

# Wells and Springs of Leicestershire

By

L. Richardson, F.R.S.E., F.G.S.



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## PREFACE

Leicestershire is a county which lies almost wholly in the drainage basin of the River Soar, a tributary of the Trent. The geological systems which are found in it are principally the Pre-Cambrian, the Carboniferous, the Triassic and the Jurassic. None of these contains a really important water-bearing stratum; consequently large supplies of good water have not been obtained from underground sources in Leicestershire to a notable extent. In some of the coal mines much water has to be pumped but it is of a quality not suitable for manufacturing or for domestic purposes. Small local supplies, however, have been obtained in many places. The larger centres of population have for the most part had recourse to surface supplies or to sources of water beyond the limits of the county.

This memoir contains records of the wells and springs of the whole county together with a selection of chemical analyses sufficient to show the principal types of water obtained. A number of the boring records have already been published in other memoirs of the Geological Survey which contain descriptions of the general geology of different parts of the area. The whole of the information relative to water-supply has been verified as far as possible and brought up to date. The author desires to acknowledge with thanks the services of all those who have furnished particulars of wells, borings and springs, in particular he is indebted to William Keay, Esq., M.Inst.C.E., of Leicester, who most generously supplied him with all the information of value contained in the well-kept records in his office.

JOHN S. FLETT,  
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28, Jermyn Street,  
London, S.W.1.

23rd February, 1931.

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## NOTE

## WORKS FREQUENTLY QUOTED IN THE TEXT

Fox-Strangways, C.—The Geology of the Country between Atherstone and Charnwood Forest (*Mem. Geol. Surv.*), 1900. Quoted as the '*Atherstone Memoir*.'

—, —.—The Geology of the Country near Leicester (*Mem. Geol. Surv.*), 1903. Quoted as the '*Leicester Memoir*.'

—, —.—The Geology of the Leicestershire and South Derbyshire Coalfield (*Mem. Geol. Surv.*), 1907. Quoted as the '*Coalfield Memoir*.'

Eastwood, T., and others.—The Geology of the Country around Coventry (*Mem. Geol. Surv.*), 1923. Quoted as the '*Coventry Memoir*.'

Lamplugh, G. W., and others.—The Geology of the Melton Mowbray District and South-east Nottinghamshire (*Mem. Geol. Surv.*), 1909. Quoted as the '*Melton Mowbray Memoir*.'

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[Information in square brackets has been added by the author.]



# WELLS AND SPRINGS OF LEICESTERSHIRE

## I.—INTRODUCTION

Leicestershire is one of the most centrally situated and most compact of English counties among which it ranks in size (824 square miles) twenty-seventh. In plan it is roughly a pentagon, and of its perimeter of 164 miles no less than 70 consists of rivers and brooks. Its land-relief must be described as undulating: the prominent high ground is situate (1) in the Charnwood Forest area, where Pre-Cambrian rocks protrude through a mantle of Triassic (principally Keuper Marl) deposits and attain at Bardon Hill—the highest ground in Leicestershire—a height of 912 ft.; and (2) along the eastern part of the country through which runs the main escarpment of the Middle and Upper Lias, locally capped with outliers and portions of westward extending spurs of formations belonging to the Oolites.

The River Soar, which flows across the county from south to north, divides it into two nearly equal parts, distinct as regards 'solid' rock-structure, and, to a lesser extent it is true, the occupations of the inhabitants. The eastern portion is floored with Jurassic rocks—locally thickly covered by Glacial deposits—and is essentially an agricultural district; the western portion is mainly floored with Triassic rocks—principally Keuper Marl (locally covered by Glacial deposits)—through which, however, protrude the Pre-Cambrian rocks of Charnwood Forest, the granite of Mount-sorrel, the syenite of Markfield, Groby, Enderby, Croft, etc., and the Coal Measures of the Leicestershire Coalfield around Ashby-de-la-Zouch. Although to a great extent agricultural this latter portion of the county has other, and at many localities more predominant, interests, such as quarrying and coal mining.

### TABLE OF STRATA

In the following table the geological divisions and subdivisions of the rocks occurring within the county are stated in descending sequence.

SUPERFICIAL DEPOSITS						Approximate Thicknesses
<i>Recent to Pleistocene</i> :—						Ft.
RECENT :	Alluvium	...	...	...	...	up to 40
POST-GLACIAL :	River-terraces	...	...	...	...	„ 30
GLACIAL :	Boulder Clay, sand and gravel	...	...	...	...	„ 200

SOLID FORMATIONS						
<i>Jurassic</i> :—						
' INFERIOR OOLITE ' :	{ Lincolnshire Limestones with occasional Limestone : thin beds of clay in the lower part					„ 26
	{ Lr. Estuarine Ser. <sup>1</sup> : Sands and clays					„ 26
	{ Ironstone <sup>1</sup> : Ferruginous sandstone and ironstone					„ 24
	{					

<sup>1</sup> These beds together are frequently spoken of as ' Northampton Beds.'

		Approximate Thicknesses Ft.
LIAS :	Upper : Clay and shale with a few thin beds of limestone ... ..	110 to 180
	Middle : Marlstone ... ..	0 to 130
	“Sandy Beds”—clays, shales, and sandy shales with occasional bands of impure limestone ... ..	60 to 100
	Lower : Clays with, in the Vale of Belvoir, the Ferruginous Limestone Beds at about 200 ft. above the Hydraulic Limestone Series	up to 750
<i>Triassic :—</i>		
RHAETIC :	Upper : White Lias ... ..	absent
	Cotham Beds—principally clays or marls ... ..	11
	Lower : Black shales with <i>Pteria contorta</i> ...	30
KEUPER :	Keuper Tea-green Marls ... ..	15
	Marl : Red marls : Arden Sandstone (Upper Keuper Sandstone). Red marls with locally sandstone beds in the lower portion in places passing down into	up to 600
	Lower Sandstones, pinkish and white, Keuper locally separated by bands of Sand-marl with in places at the base stone : breccia ... ..	100 to 330
	BUNTER : Pebble Beds: Pebble beds and sandstones	0 to about 1,000
<i>‘Permian’ :—PERMO-TRIAS</i>		
Breccia with occasional beds of reddish sandstone and purplish marl occupying old depressions in the Carboniferous rocks ... ..		0 to 50
<i>Carboniferous :—</i> <span style="float: right;"><i>Unconformity</i></span>		
COAL MEASURES <sup>1</sup> :	Middle or Productive Series.	
	(a) Shales, etc., with several (? impersistent) beds of coarse gritty sandstone (Moirs Grits) in the upper portion, pottery clays, and thin coal seams ... ..	1,500 to 1,600
	(b) Shales, etc., with workable coal seams—the Roaster Coal the lowest in the east; the Kilburn Coal in the west ... ..	600 to 700
	Lower or Unproductive Series.	
MILLSTONE GRIT : and UPPER LIMESTONE SHALES :	Shales, etc., with a few thin coal seams ... ..	500 to 600
	Massive sandstones and grits passing down into coarse and pebbly grits	up to 500
CARBONIFEROUS LIMESTONE :	Shales, thin sandstones, and occasional beds of limestone ... ..	0 to 360+
	Limestone, massive ... ..	0 to 500
<i>Unconformity</i>		
<i>Silurian and/or Cambrian :—</i>		
Shales and slaty rocks.		

<sup>1</sup> At Whitwick Colliery and as far south as Ellistown a sheet of dolerite overlies the Coal Measures. It is 21 ft. thick in the Whitwick Colliery.

*Unconformity**Pre-Cambrian* :—

CHARNIAN :

Slates, hornstones, agglomerates,  
etc., with intrusive igneous rocks.

Leicestershire is not well off in the matter of water supplies from underground sources. The greater part of the county is on practically impervious Keuper Marl and Lower Lias clay and the only water-bearing beds worth mentioning are the Triassic conglomerates and sandstones, Marlstone in the Melton Mowbray Rural District, and Glacial sands and gravels. Of these, although the Glacial sands and gravels furnish supplies for Lutterworth and Market Harborough, only the Triassic sandstones and conglomerates contain supplies adequate for considerable demands, but, unfortunately, when the water in the sandstone is tapped under any considerable thickness of marl it is usually found to be so hard, and not infrequently saline (Sodium Chloride), as to be unsuitable for public supplies. Consequently, towns such as Leicester and Loughborough have had to have recourse to impounding schemes; but when for Leicester, owing to increasing consumption, such schemes became inadequate, sources of supply had to be sought for outside the county.

## GEOLOGICAL FORMATIONS

## PRE-CAMBRIAN

Pre-Cambrian and Palaeozoic rocks floor the county beneath the Triassic conglomerates and sandstones.

Pre-Cambrian rocks occur at the surface in the Charnwood Forest District, and syenite, granite, etc., project through the Keuper Marl at Mountsorrel, Enderby, Croft, etc.

The Charnwood Forest District, however, is the most important area for Pre-Cambrian rocks. Here the rocks of this era consist of slates, hornstones, agglomerates, etc., with intrusive igneous rocks. The rocks are practically unproductive of water—a well, 70 ft. deep, at Bawdon Castle failed to yield a supply—but the land-relief to which they and their mantle of Triassic (mostly Keuper Marl) rocks have given rise has favoured the production of streams and has been found to be the best in the county for impounding schemes. With the exception of Bardon Hill (912 ft.) and a small area adjoining, 'The Forest' is in the River Soar drainage-basin. The Thornton Reservoir (Leicester Corporation) gathers its waters from the south-western portion of The Forest; Groby Pool—the largest natural sheet of water in Leicestershire—from the southern portion; Cropston Reservoir (Leicester Corporation) from a large area in the central portion about Ulverscroft and Chaxley; Swithland Reservoir (Leicester Corporation), from the eastern slopes; Nanpanton Reservoir (Loughborough Corporation), from a north-eastern portion; and Blackbrook Reservoir (ditto), from the north-western portion. But so far as Leicester was concerned the available streams



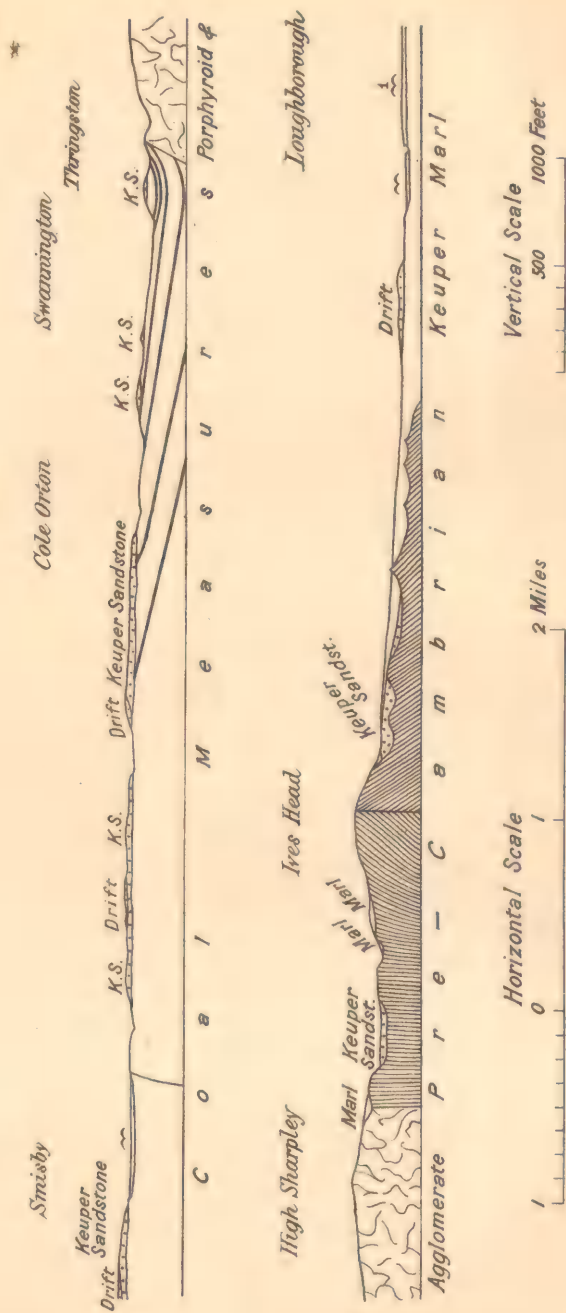


FIG. 1.—Section No. 1, Smisby to Loughborough.

from the district proved to yield too limited and unreliable supplies for the growing city's needs and the Derwent Scheme had to be carried out.

The Charnwood Forest District is very poor in springs.

The Pre-Cambrian and Palaeozoic floor is irregular and of diverse rock composition. Judging from the facts obtained where the rocks occur at the surface and from deep borings it is useless to drill through the Mesozoic rocks into the Palaeozoic and Pre-Cambrian floor in search of water.

#### CAMBRIAN AND SILURIAN

Black shales, in most cases of Cambrian age, and slaty rocks have been proved in a number of borings; but, owing to their lack of interest from the present standpoint, need not be discussed here.

#### CARBONIFEROUS

Particulars of the Carboniferous rocks are given in the table on p. 2.<sup>1</sup> The Carboniferous rocks come to the surface in the north-western portion of the county—around Ashby-de-la-Zouch.

An anticlinal axis striking N.W. and S.E. runs through Ashby-de-la-Zouch so that the Coal Measures to the east have a prevalent north-easterly dip, and to the west a prevalent south-westerly dip. Owing to the anticlinal flexure the older Coal Measures, the Lower or Unproductive Measures, occur at the surface and floor a considerable area of which the centre is occupied approximately by the town of Ashby-de-la-Zouch. The succeeding Middle or Productive Measures lie to the east and west. Those to the east, in the Coalville District, constitute what is usually known as the Leicestershire Coalfield; those to the west, in the Moira-Swadlincote District, what is usually known as the South Derbyshire Coalfield. Higher beds (division (a) in the table on p. 2) are present in the latter than in the former coalfield, and, in their uppermost portion, contain the only aquifers worth mentioning in the Coal Measures of Leicestershire, namely, the Moira Grits.

“Several of the coal seams in the western part of the Coalfield exude salt water. This was noted many years ago with regard to the Main Seam at Moira, where the water was pumped for the use of the baths at Ashby and Moira; which were, in the early part of the last century, in much repute for rheumatism and other affections. The water contains a large proportion of chloride of sodium, but it appears to obtain its chief value from the presence of a small percentage of bromine. . . .

“The presence of this water does not appear to have been noticed until about 1832, when the deeper mines at Moira had been sunk. The shallower pits do not yield saline water, but below 300 feet it is mostly salt and very little fresh is obtained. The Moira pits

<sup>1</sup> A detailed account of the Carboniferous rocks is given in the ‘Coalfield Memoir.’

do not give much water owing to the measures being broken up by numerous faults, which form barriers to the springs. It is found that when the salt water exists the coal seam is enclosed between layers of impervious clay, and that it is never found when the place of this clay is occupied by a sandstone. The water oozes from the coal seam, and never runs freely, for which reason the coal is said to 'bleed'.

"Besides the Main Coal, salt water has been found in the Little Coal and the Woodfield Coal near Swadlincote, and in a seam possibly the Main at Snarestone; in fact most of the seams in the western part of the coalfield 'bleed' salt water.

"Coleman states that salt water originally rose in the 'Salt Spring Close' at Donisthorpe, but when the Double Pits were opened this spring was drained off."<sup>1</sup>

Coal Measures extend from the visible coalfield south-eastward, beneath the Trias, to a point somewhere in the neighbourhood of Desford.

Millstone Grit occurs at the surface in three very small areas, all to the north of the coalfield: (1) north of Castle Donington (sandstone); (2) in the vicinity of Spring Wood, Staunton Harold (basal coarse pebbly beds); and (3) near Thringstone. It has been penetrated apparently (1) beneath the visible Coal Measures by the boring at Lount; (2) beneath the Triassic rocks by the Piper Wood borings near Shepshed; and (3) beneath the Permo-Trias by borings at Hathern (pp. 95-100). South of the visible coalfield (beneath Trias and Coal Measures) the borings at Nailstone and Desford "have apparently penetrated beds of this age, but the descriptions given are too indefinite to calculate what thickness should be assigned to this formation."<sup>2</sup>

North of Staunton Harold, around Melborne in Derbyshire, the Millstone Grit floors a considerable tract, is water-bearing, and its store is drawn on at Stanton-by-Bridge for the supply of Melborne, Castle Donington and Long Eaton.

Carboniferous Limestone emerges on the Charnwood anticline on the north-east flank of the Leicestershire Coalfield as inliers—near Thringstone, Osgathorpe, at Breedon Cloud, Breedon Hill, and—together with shales—at Staunton Harold. According to Fox-Strangways<sup>3</sup> the beds "appear to be bounded on either side by large faults. On the western side the beds are fairly flat, but on the eastern side they are sharply bent up, and dip westwards at a high angle."

The Limestone apparently occurs locally beneath the Trias to the east of Breedon Cloud, for it appears to have been reached in the boring at Piper Wood near Shepshed. Beneath the visible Coal Measures it—or more likely the Upper Limestone Shales—appears

<sup>1</sup> 'Coalfield Memoir,' p. 109.

<sup>2</sup> 'Coalfield Memoir,' p. 17.

<sup>3</sup> 'Coalfield Memoir,' p. 15.



to have been touched in the boring at Lount<sup>1</sup> (about half-way between Ashby-de-la-Zouch and Breedon-on-the-Hill), and south of the visible coalfield (beneath Trias and Coal Measures) at Ibstock<sup>2</sup> and at Nailstone; while the Limestone proper was encountered in the "Desford Boring" near Stocks House Farm, Peckleton.

The Upper Limestone Shales were entered by the No. 2 boring at Hathern Brickworks in 1930. The cores yielded species of *Eumorphoceras* and *Anthracoceras*, characteristic of the Eumorphoceras Zone, E<sub>2</sub> of the lower part of the Millstone Grit according to the new classification of these beds.

#### TRIAS

The rocks that succeed the Palaeozoic belong to the Triassic System. The latter rest on a very irregular surface of the former, and, locally, higher divisions of the Trias overstep the lower. During the gradual levelling up of the irregularities in the Palaeozoic floor debris from the Pre-Cambrian and Palaeozoic rocks became incorporated in the encroaching Triassic deposits so that breccias are met with at several horizons. The determination of the age of many of the breccias mentioned in logs of well- and shaft-sinkings is fraught with much difficulty and the difficulty is increased by the knowledge that breccias also occur in the Upper Coal Measures on which the Trias locally rests and that the age of these and basal Triassic breccias have by some been regarded as Permian.

Where distinctly developed the Trias is divisible, in descending sequence, into Keuper Marl, Lower Keuper Sandstone, Upper Mottled Sandstone, Pebble Beds, and Lower Mottled Sandstone. The last is absent from Leicestershire. The Pebble Beds are typically developed at certain localities, but at others the pebbles are sparingly distributed and sand-beds devoid or nearly so of pebbles are considered to be referable to this subdivision. To add to the difficulty of classification pebbles occur locally in the lower beds of the Lower Keuper Sandstone, and the natural lines of demarcation between Bunter and Lower Keuper Sandstone, and Lower Keuper Sandstone and Keuper Marl, are locally indefinite—one subdivision graduates as regards lithology into the other. Accordingly in the interpretation of many of the records of well- and shaft-sinkings given in the following pages only such classification as has been deemed advisable has been given.

In the Midlands the sandstones and pebble beds of the Trias constitute a very important source of underground water. As a rule, the more deeply the beds are buried beneath Keuper Marl the harder is the contained water and the more likely is it to be saline. Also the farther away from its outcrop a sandstone bed is, the less—as a rule—is its contained water (which is usually carried in fissures) and the greater the risk of over-pumping.

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<sup>1</sup> 'Coalfield Memoir,' p. 15.

<sup>2</sup> *Idem*, p. 15.

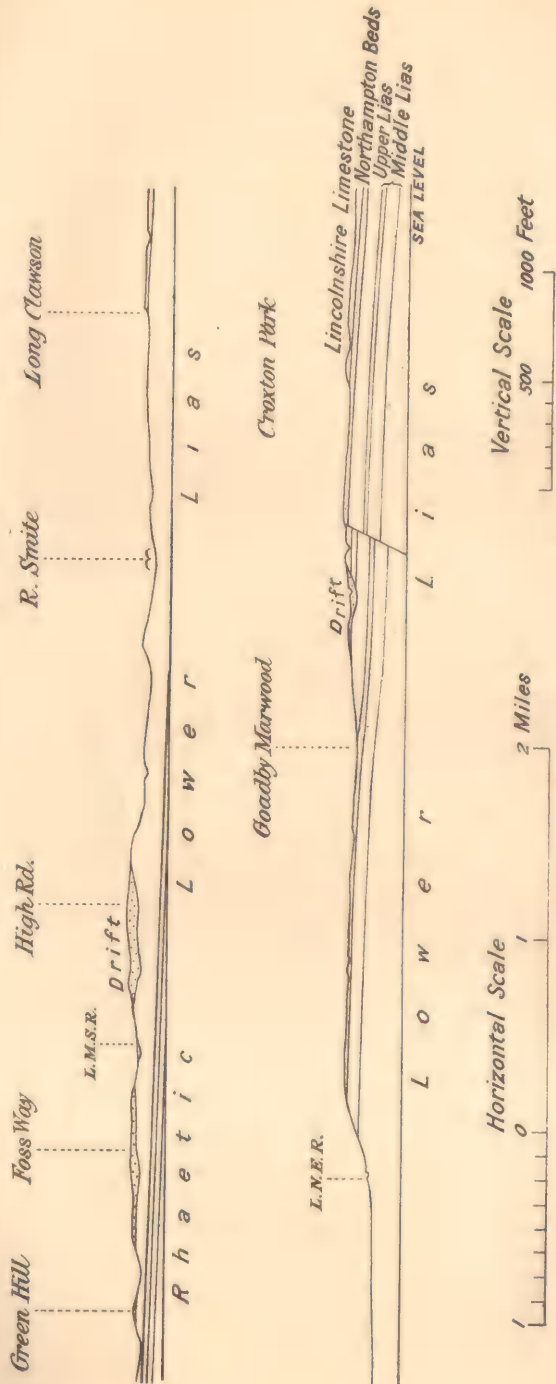


FIG. 2.—Section No. 2, Green Hill to Croxton Park.

Dealing with the Trias of Leicestershire as a whole there is little to add to what has already been published by previous observers—notably C. Fox-Strangways. Stress, however, may be laid on one (1) matter and attention directed to two (2, 3) others.

(1) In the Lower Keuper Sandstone and/or in the sandstone layers in the lower portion of the Keuper Marl which overlie the Coal Measures of the south-eastern extension of the Leicestershire Coal-field a very large quantity of water is present. Large quantities are pumped daily from the collieries :—

	Colliery	Approximate quantity	
		pumped daily (in gallons)	Hardness (in degrees)
Bagworth	...	270,000	70
Desford ...	...	190,000	90
Ellistown	...	400,000	33
Ibstock	...	250,000	38
Nailstone	...	90,000	82
S. Leicestershire	...	100,000	—

Much of the water is unfit for public use and is also excessively hard—the hardness increases from north to south. Should, however, it be contemplated drilling for water in this area, it should first be ascertained to what extent the source of supply would be likely to be affected by pumping at any colliery.

(2) Permeable Triassic beds (*i.e.*, sandstones and pebble beds) have a greater south-eastward extension from the Oakthorpe-Chilcote area than was probably at one time expected, as is demonstrated by the Shackerstone Boring (pp. 73-76).

(3) The general conclusion arrived at after a study of deep borings in Leicester City is that the quantity of water to be obtained by drilling has frequently fallen short of expectations. A prevalent impression is that large quantities of water are to be met with under gypsum-beds in the Keuper Marl, but this impression requires further support from carefully observed facts. It is known that very varied results have attended borings that have been made through the Marl into the underlying Lower Keuper Sandstone: in one case there was no supply.

The greater part of western Leicestershire has for its 'solid' rock floor Keuper Marl. The Keuper Marl cannot be regarded as a water-bearing formation and such water as is met with is usually very hard. Dug wells, however, sunk with the object of meeting small requirements usually yield an adequate supply and better results are obtained if they—or even boreholes—traverse skerries of Upper Keuper Sandstone. In the case of dug wells it is important to ensure that all surface water is excluded.

Certain observations by previous authors may now be given.

*Bunter.*—Bunter beds occur at the surface in only very small tracts in Leicestershire: (1) in Oakthorpe parish near Ashby-de-la-Zouch, and (2) about a mile and a half westward of Castle Donington. They probably have a maximum thickness of about



1,000 ft. : a thickness of 599 ft. 8 in. was proved by the Chilcote Boring, but over most of the ground where they crop out the thickness does not appear to be so much.

Fox-Strangways has remarked<sup>1</sup>: "The Bunter conglomerate is one of the most valuable water-bearing strata in the Midlands, but around this [Leicestershire] Coalfield the beds are very irregular in their outcrop and in many cases disappear altogether. Several boreholes have penetrated these beds, but much additional information is required before a very reliable estimate can be formed of their water-bearing capacity in this district. These beds would appear to be thickest to the south-west of the Coalfield and would no doubt yield a good supply of water in that neighbourhood." Also ('Coalfield Memoir,' p. 63), "towards the east [from the Oakthorpe area] . . . [the Bunter Beds] gradually thin away," and ('Loughborough Memoir,' 1905, p. 30) . . . "crop out almost entirely in the south-west quarter of the map [Sheet 141], where they appear to be thickest; they die out to the east, and probably were not deposited much to the east of a line drawn through Castle Donington and Ashby, although the boring at Hathern shows that they were abnormally thick [but see p. 100 of this memoir] in what is now the valley of the Soar."

*Lower Keuper Sandstone.*—It has been remarked concerning the sandstone of the area represented (1) on Sheet 169 ('Coventry Memoir,' p. 124): "[It] . . . proves disappointing, the water . . . being unfit for drinking, owing to the large amount of saline matter. Thus at Hinckley several attempts have failed, not because the quantity was insufficient, but through the difficulty of keeping out saline waters." (2) On Sheet 155 ('Atherstone Memoir,' p. 3): "The chief water-bearing stratum of the district is the Lower Keuper Sandstone, the porous divisions of which contain a very large amount of pure water." And on Sheet 141 ('Loughborough Memoir,' p. 4): "This rock has not a very extensive outcrop in this district and therefore its water-bearing capacity is not so great as is usually the case."

#### LIAS

*Lower Lias.*—The Lower Lias is the 'solid' rock that floors nearly the whole of the vale-land of Leicestershire to the east of the River Soar. In the Vale of Belvoir it appears to be about 670 ft. thick; in the neighbourhood of Melton Mowbray, about 650 ft.; while in the south of the country it may be upwards of 750 ft. thick.

Except for the Hydraulic Limestone Series (thickness about 20 ft.) in the bottom portion, the Series is, as a rule, almost wholly clay and shales. The supply of water in the Hydraulic Limestone Series is scanty and hard. The little that may be encountered in the clays and shales is hard, and liable to be saline and/or to be impregnated with sulphuretted hydrogen from the decomposition of the

<sup>1</sup> 'Coalfield Memoir,' p. 108.

iron pyrites in the beds. Practically all the deep wells and borings that have been sunk into the clays and shales have been unsuccessful.

In the lower half of the main mass of clay and shales, at about 220 ft. above the base, from Muston, near Bottisford, south-westward to Harby, are some thin Ferruginous Limestone Beds on or near the outcrop of which are located the villages of Muston, Redmile, Barkestone, Plungar, and Harby.

From the preceding remarks it will be evident that it is inadvisable to drill into—and, it may be added, through—the Lower Lias in search of water.

The occurrence of saline water in a hollow in the Lower Lias clay led to the erection of, and the sinking of a well at, Shearsby Spa (see p. 58); the discovery of similar water in a well, to the origin of Belvoir Spa (see p. 33); and the presence of saline matter and—to a less extent—sulphuretted hydrogen to the fame of the Burton Lazars water (see p. 85).

*Middle Lias.*—The main escarpment of the Middle Lias runs through east Leicestershire, and, in advance of it, are a few outliers of which the most important and most distant is that which may be called the 'Gumley Outlier.'

In Leicestershire the Middle Lias consists of two subdivisions:—

Marlstone—calcareous sandstones passing into ironstone,

'Sandy Beds'—clays, shales and loams with bands of impure limestone, and ranges in thickness between 60 and 130 ft.

"In the south both [subdivisions] are thin, and at Market Harborough the marlstone is absent. On the south side of Slawston Hill it is scarcely traceable, and the Middle Lias as a whole has a thickness of 60 to 70 ft. Northwards of Hallaton the marlstone is less than a foot in thickness, 2 ft. at Godeby and Horninghold, 2½ ft. at Allexton. . . .

" . . . at Tilton-on-the-Hill and Somerby the marlstone is 18½ ft. thick, while it appears to be still thicker about Billesdon and Burrow-on-the-Hill. In the Melton Mowbray district it reaches 30 ft. and maintains this thickness to the county boundary.

"The underlying Middle Lias clays correspondingly expand in a northerly direction and reach a thickness of about 100 ft. in the Melton Mowbray district. . . ."<sup>1</sup>

From near Old Dalby to Belvoir Castle the Marlstone gives rise to a bold escarpment overlooking the vale-land that is floored with Lower Lias.

Owing to the Sandy Beds being more argillaceous in this county than further south little water is to be met with in them: the bulk that may be encountered in them or may issue in the form of small springs will be in or from the few impure limestone bands. The Marlstone on the other hand is one of the best water-bearing formations in Leicestershire—a fact that has been long appreciated as is

<sup>1</sup> 'Thicknesses of Strata,' (*Mem. Geol. Surv.*), 1916, p. 82.

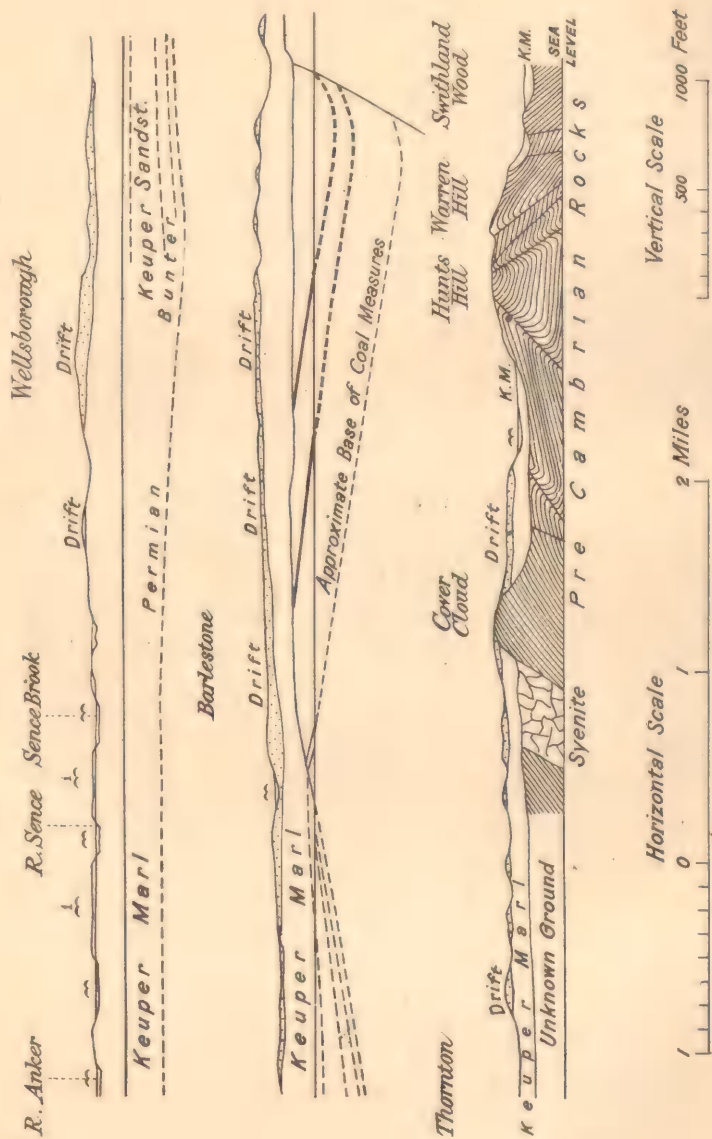


FIG. 3. Section No. 3, River Anker to Swithland Wood.



shown by the numerous villages that are located on or near it. The bulk of the water is contained in the numerous small fissures with which the rock is traversed. Owing to the ferruginous nature of the rock, however,—it is extensively worked for iron in the Melton Mowbray and Belvoir Rural Districts—the water is liable to be chalybeate: an Iron- (weak) Saline Spring at Gumley was held for some time in considerable repute. Owing to the subjacent Sandy Beds being largely argillaceous water locally issues as springs from at or near the base of the Marlstone: springs from this horizon constitute the sources of piped supplies to Melton Mowbray, Coston, Sproxtton, Knipton and Harston. Knipton Reservoir, which impounds the head-water of the River Devon, is maintained with water from springs from the Middle Lias.

*Upper Lias.*—"In Leicestershire . . . [the Upper Lias] ranges between 110 and 180 ft., and near Melton Mowbray . . . averages about 120 ft."<sup>1</sup> ". . . from its generally impervious character, [it] gives the poorest supply of any formation, as the water is only held in thin limestone beds; and from the pyrites in the shales it is not often fit to use . . ."<sup>2</sup>

#### INFERIOR OOLITE

'Solid' formations younger than the Upper Lias belong to what may be called for the present purpose the 'Inferior Oolite,' although it is probable that the Ironstone is the only representative of the Inferior Oolite proper. They floor but small areas in Leicestershire: the principal areas are—(1) in north-eastern Leicestershire (*a*) in the eastern portion of the Melton Mowbray Rural District and (*b*) in the south-eastern portion of the Belvoir Rural District; and (2) in the southern portion of the Hallaton Rural District in the vicinity of Nevill Holt.

The 'Inferior Oolite' consists, in descending sequence, of:—

		Ft.
Lincolnshire	} Limestones with occasional beds of	
Limestone:		
Lower Estuar-	} clay in the lower part ... .. up to 26	
ine Series:		
Northampton	} Sands and clays ... .. „ 26	
Ironstone:		
	} Ferruginous sandstone and iron-	
	} stone ... .. „ 24	

These rocks are in the main permeable and probably, as a rule, water that falls as rain on the Lincolnshire Limestone eventually reaches that which is held up or thrown out as springs by the Upper Lias clay. Cases probably occur, however (as Hamwell Spring, Bescaby), in which clay beds in the lower part of the Lincolnshire Limestone hold up water. Saltby, Croxton Kerrial, and Belvoir have piped services from springs from the base of the 'Inferior Oolite'; Buckminster one from a well in the Ironstone near Sewstern.

<sup>1</sup> 'Thicknesses of Strata,' (*Mem. Geol. Surv.*), 1916, p. 82.

<sup>2</sup> 'Leicester Memoir,' p. 6.

## GLACIAL DEPOSITS

The greater part of the surface of the 'solid' rocks of Leicestershire is covered, but, of course, by no means uniformly, with Glacial deposits. These are thicker and more important east of Leicester and the Soar valley than in the western half of the county. "They fill and level up minor irregularities of the pre-glacial surface and reach a thickness of at least 150 ft. in the old hollows. Around Melton Mowbray also they are 200 ft. thick in places. A boring at Garthorpe . . . [ $5\frac{1}{2}$  miles E. by N. of Melton Mowbray], traversed at least 50 ft., but along the Rutlandshire border the thickness seldom exceeds 10 ft."<sup>1</sup>

It is unnecessary to enter here into details of the constituent deposits of the Glacial beds or of their correlation; it will suffice to give the following information: as a rule east of the River Soar the highest subdivision is a locally thick deposit of Boulder Clay. In the lower part of this Boulder Clay deposits of sand and gravel are in places present. The main mass of Boulder Clay overlies, as a rule, sand and gravel, which, in the vicinity of the River Wreak, passes down into loam. Boulder Clay with subjacent sand and gravel extends southwards into the Market Harborough country in which locally irregular, but in places thick, accumulations of coarse gravel are conspicuous in the Boulder Clay.

West of the Soar (1) north of Charnwood Forest (Sheet 141), that is, in the country around Diseworth, the Glacial deposits cover comparatively small areas capping only the relatively higher ground, but the order is—Boulder Clay overlying sand and gravel. The Coal Measures of the Leicestershire Coalfield are but little obscured by Glacial deposits. (2) South-west of Charnwood Forest (Sheet 155), that is, in the country around Market Bosworth, the succession, in descending order, is: sand and gravel, Boulder Clay, sand and gravel—but it is the lower sand and gravel that is the thicker and more extensive. The Boulder Clay is thickest from the neighbourhood of Market Bosworth southwards: "a boring to the immediate north-east of Market Bosworth showed 40 ft. of boulder-clay; another at Bosworth Wharf 27 ft.; and another at Kingshill over 100 ft. At Osbaston, near Market Bosworth, a brickearth free from stones extended to a depth of 40 ft. below the present valley."<sup>2</sup> The fact that the lower sand and gravel floors many parts of this district accounts for the occurrence of many villages. But although the Glacial deposits have been thus described from a subdivisional standpoint it must be pointed out that "The Drift over this ground as a whole is more sandy or gravelly than further to the east, and except along a north and south line in the neighbourhood of Market Bosworth, there are no very thick deposits of Boulder clay."<sup>3</sup>

In general, owing to so great a part of Leicestershire being flooded

<sup>1</sup> 'Thicknesses of Strata' (*Mem. Geol. Surv.*), 1916, p. 79.

<sup>2</sup> 'Thicknesses of Strata,' (*Mem. Geol. Surv.*), 1916, p. 79.

<sup>3</sup> 'Coalfield Memoir,' p. 70.

with impervious 'solid' rocks, if it had not been for the occurrence of Glacial sand and gravel the county would have been very sparsely inhabited: such is the case where the tough Boulder Clay forms a thick mantle.

The distribution of the Boulder Clay and sand and gravel may be readily ascertained from the Geological Survey maps; reference should always be made to the map for the district before a deep well or boring is embarked upon. The majority of deep wells and borings that have been made into the thick Boulder Clay have proved unsuccessful; in the few cases in which success is claimed it is probable that veins, layers or pockets of sand and gravel have been pierced, but the water is always hard and the supply likely to be soon exhausted by over-pumping. In certain cases it would appear that more satisfactory results would have been obtained if the borings had been carried into the subjacent sand and gravel.

The sand and gravel that is as a rule present beneath the Boulder Clay is a very useful aquifer. Where the overlying Boulder Clay has been removed by denudation the deposit has been selected for the site of many a village—on the high ground in the eastern part of the county as well as in the wide-spreading lowland. Market Harborough and Lutterworth both derive their public supplies from Glacial sand and gravel. William Keay informs me: "Leicestershire is not blessed with any springs of importance. The best are probably those in the thick gravel areas in the neighbourhood of Lutterworth and Market Harborough"—in the parishes of Misterton, Dunton Bassett, Mowsley, and North Kilworth. A dry bed to a water-course usually indicates that it is fed not by springs but only by surface water. The water is hard; that of many springs—for example, at the once well known Hinckley Spa; Reed Pool, Foston; and Houghton-on-the-Hill—slightly chalybeate.

While sand-deposits provide dry sites for houses and water—usually adequate for limited requirements—readily obtainable by means of shallow wells, the danger is that where such deposits are built upon, if great care is not exercised, the source of drinking-water becomes polluted.

Dr. C. A. Moore observes:<sup>1</sup> "In the drift covered area . . . the position of the villages is generally determined by beds of gravel yielding springs. . . .

"With respect to the influence of soils upon the health of the people living upon them, sandy and gravelly soils are always healthy sites, except when they are low-lying, and thus become water-logged. In soils of this kind a persistently low ground water level is always healthy; a persistently high level is unhealthy, and when the ground water level fluctuates suddenly and considerably, it is more unhealthy still. Low-lying clayey soils are unhealthy, and favour the development of phthisis, rheumatism, and colds; and with

<sup>1</sup> *Trans. Leicester Lit. and Phil. Soc.*, vol. i, pt. 2, 1887, p. 20.



regard to geological strata generally, those which favour the retention of moisture are unhealthy, while those which are dry are healthy sites.

"If a soil in addition to being damp, is polluted by leakage from defective drains or cesspools, the bad effect is increased and such diseases as diarrhoea, typhoid fever, and cholera, are spread amongst the dwellers on such sites, either by consumption of polluted water, or by breathing polluted air.

"Soil not only acts as a mechanical filter, but it has been shown by a number of experiments, at Rothamsted, that sewage undergoes a process of nitrification, that is to say, in its passage through the soil it meets with minute organisms which cause an oxidation of the ammonia and other nitrogenous bodies into nitrates and nitrites. It is probably owing to this change, effected by a porous soil upon the liquid filth percolating through it, that people are sometimes able to drink with impunity the water from a well which is obviously exposed to pollution. There, is however, always great risk that the soil in the neighbourhood of such a well may be over-taxed with filth, and that some portion of the polluting liquid may escape complete decomposition. There is in fact no evidence that percolation through the soil, even if it has the power of rendering harmless the organic matter which may give rise to sporadic outbreaks of fever, has any effect on specific poisons or germs."

#### RIVER TERRACE GRAVEL

Flanking the principal rivers, the Soar and the Wreak, are patches of gravel—remnants of river-terraces. On such are situated alongside (1) the Soar—Leicester (old part), Thurmaston, Syston, Quorndon (mainly), Loughborough, and Hathern; and (2) the Wreak—Rotherby, Frisby-on-the-Wreak, Asfordby, etc. The reason for the selection of the sites occupied by these places is obvious—dry sites with water available by means of shallow wells; but the well-waters are liable to pollution from sources similar to those mentioned when dealing with wells in the Glacial sands.

#### ALLUVIUM

The River Soar from Croft to its junction with the River Trent is margined with Alluvium of variable—locally considerable—width. The level, low-lying ground to which it gives rise is subject to flooding and therefore has few buildings on it. Gravel belonging to the locally flanking river terrace doubtless in places extends beneath the Alluvium river-wards; but water tapped in gravel beneath Alluvium is usually found to be unsuitable for potable purposes owing to the presence of an excess of organic matter. Alluvium is found locally forming fairly extensive spreads alongside the River Wreak up to above Melton Mowbray; also margining the lower

reaches in particular of the larger brooks. Melton Mowbray is mainly on Wreak-side Alluvium; Bottesford is on an alluvial deposit of the River Devon.

#### RAINFALL

The average rainfall of Leicestershire is between 25 and 30 inches, but the eastern side is drier than the western and than an area (where the rainfall is in excess of 27.5 inches) that coincides very closely with the Charnwood district. "As a result of continuous observations, extending over a period of thirty-four years, it appears that the wettest months at Thornton Reservoir, on the edge of the Charnwood district, are July, August and October, while the driest are February and March. Heavy summer and autumn rains are indeed characteristic of most parts of the Midlands."<sup>1</sup>

Particulars obtained from 31 stations in Leicestershire are published in 'British Rainfall' for 1926.

#### RIVERS

G. N. Pingriff—in *Cambridge County Geographies*—Leicestershire (1920), p. 19—says: "Leicestershire cannot boast of any very imposing rivers, but it is closely and uniformly covered by a net-work of small streams, mostly flowing into one main artery—the Soar—which runs into the Trent on the northern boundary of the county. These numerous streams have contributed greatly to the agricultural prosperity of the county."

On reference to the map on p. 18 it will be noticed that by far the greater part of the county lies within the drainage-basin of the River Soar: only comparatively small areas occur within the drainage basins of other rivers—the Stratford or Upper Avon (Severn System), Welland, Witham, Devon, Mease, and Anker (Trent System).

Much useful information concerning the rivers and canals of Leicestershire is given in Vol. x of the Reports of the Royal Commission on Canals and Waterways—"Vol. x. Reports on the Water Supplies of Canal Routes by R. B. Dunwoody to the Water Supply Committee of the Royal Commission appointed to enquire into and to report on The Canals and Inland Navigations of the United Kingdom. 1911."

#### RIVER AVON

The extreme southern part of the county around Lutterworth (41 square miles) is drained by the south-westward flowing Stratford or Upper Avon and its tributary the River Swift. The River Avon rises at Naseby in Northamptonshire, enters Leicestershire at Welford, and thence to the Watling Street—some six miles—forms the county boundary. On its line near Naseby,

<sup>1</sup> Pingriff, G. N., *Cambridge County Geographies*—Leicestershire, 1920, p. 50.





The parent river rises within the county near Husband's Bosworth. The Saddington Reservoir,<sup>1</sup> a feeder of the Grand Junction Canal, impounds the waters of the *Laughton Brook*. Running almost parallel with the Laughton Brook to the west is the *Mowsley Brook* which is maintained mainly by the Mowsley Springs (p. 80). H. G. Coales gauged this brook in July, 1914, where it is crossed by the Mowsley-Saddington road west of Saddington Reservoir, and "found 83,000 gallons a day passing, of which the tributary brook from the Saddington Lodge watershed furnished 23,000 gallons; having 60,000 gallons coming down from Mowsley."<sup>2</sup> The Welland forms the county boundary from its source to near Rockingham Station, Rutland, and its tributary the *Eye Brook*, from near East Norton to that station. The Welland is quickly affected by heavy rains; it rises rapidly and soon overflows its banks. In 1880, during a great flood, the water stood many feet deep in the square at Market Harborough.

#### RIVER DEVON

The north-eastern portion of the county (1) east of the escarpment of the Marlstone between Eastwell and Belvoir is drained by the River Devon (on the line of which, formed by impounding, is the Knipton Reservoir—a feeder of the Grantham Canal) (see p. 33); and (2) west of that escarpment, by the *River Smite* (see p. 88)—a tributary of the Devon which joins the Trent at Newark-upon-Trent.

#### RIVERS MEASE AND ANKER

The western part of the county is drained by the Mease and Anker—rivers that discharge into the River Tame: the former at Croxall (a little above the junction of the Tame with the Trent), the latter at Tamworth. The western part of Leicestershire, whose waters are carried off by the Anker, is mainly drained by the tributary of the Anker, the *River Sence*, which rises on the south-western margin of Charnwood Forest between Bardon Hill and Ulverscroft Abbey.

#### RIVER SOAR

The River Soar and its tributaries drain the greater part of the county; conversely, "Leicestershire includes an almost complete river basin—that of the Soar—which flows right across the county from south to north, dividing it into two approximately equal areas."<sup>3</sup>

Toward its head the Soar breaks up into a number of streamlets. There probably exists a difference of opinion as to which is the true source of the river, but the springs from the Glacial sand and gravel at Leicester Grange on the south side of the Watling Street just within Warwickshire may be regarded as constituting it. From this source the river flows by way of Croft, Leicester, and Loughborough into the Trent a few miles southward of Castle Eaton in Nottinghamshire. Altitudes of the river are: at Leicester Grange, about 350 ft.; Aylestone, 184·5 ft.; Leicester, 172·25 ft.; Loughborough, 129 ft.; junction with Trent, about 94·5 ft. Between Aylestone and the Trent its fall is thus only 90 ft. In consequence of (1) its slight fall, (2) it and its tributaries draining almost entirely impervious ground, from which the bulk of the rain-water sheds off soon after periods of heavy rainfall, the river rises rapidly and quickly floods the adjacent low-lying alluvial ground.

The following flood records at Leicester have been communicated by William Keay, M.Inst.C.E., F.S.I.:

<sup>1</sup> Capacity, 18,197,263 cubic feet. Ht. above O.D. of top water-level, 367·08 ft.

<sup>2</sup> Coales, H. G., 'Fleckney Water. Report to the Market Harborough Rural District Council,' 5th October, 1914. *Privately printed.*

<sup>3</sup> Pingriff, G. N., *Cambridge County Geographies—Leicestershire*, 1920, p. 6.

## FLOOD RECORDS AT LEICESTER

Year		Extent of flood
1875.	A July flood ... ..	Full
1880.	July 15 ... ..	Full
1895.	January 21 ... ..	Quarter
1897.	January 12 ... ..	Half
1900.	December 31 ... ..	Full
	On this date the River Soar rose to the top of the horizontal rail above the towing path at Newarke Street Bridge.	
1910.	December 2 and 3 ... ..	Three-quarters
1920.	December 16 ... ..	Half
1921.	August 27 ... ..	Half
1922.	August Bank Holiday ... ..	Half
1925.	May ... ..	Half
	(Large flood in Gilwiskaw Brook; Ashby-de-la-Zouch)	
1926.	February 7 ... ..	Half
	On this occasion the Hinckley Road near Gimson Road was flooded to a depth of 18 inches. The River Soar rose about 18 inches over the towing path at the Newarke Street Bridge	
1927.	December 22 ... ..	Half
	Hinckley Road flooded.	

The desirability of impounding the waters of certain head streams of the Soar for the supply of Hinckley was at one time considered but dismissed.

The *River Sence* joins the Soar a little below Narborough. It rises at Billesdon, on which account its uppermost portion is often known as the *Billesdon Brook*. According to H. G. Coales<sup>1</sup>: "The water in this stream passing under the Midland Railway near Glen Station has a good flow, roughly gauged at 200,000 gallons a day." The water was examined during the search for an additional supply to Leicester, but its quality was found to be "doubtful" (see p. 137).

Brooks flowing from the south into the Sence that have been examined in connexion with searches for water supplies are the *Fleckney*, *Kilby*, and *Shearsby Brooks*. The *Kibworth Brook* flows into the *Fleckney Brook*; according to H. G. Coales<sup>2</sup> "At the beginning of September [1914] this brook was only passing a trickle of water. . . ." Of the *Fleckney Brook* H. G. Coales reported<sup>3</sup>: "This brook as far as the Sewage Disposal Works since the middle of July [1914 to October, 1914] has been quite dry, from which one may conclude that there are no appreciable springs. . . . From the Sewage Works to the Kibworth-Wistow Road the *Fleckney Brook* commences to run, being fed by springs from Mr. Paget's land on the east of the canal. I gauged the incoming stream near the lock-keeper's house at about 30,000 gallons a day, some of which, however, might be canal leakage. . . . The *Fleckney Brook* runs into the *River Sence*, . . ." Concerning the *Kilby Brook* Mr. Coales reported: "On July 8th [1914] I gauged this brook just south of Kilby and found 16,000 gallons a day flowing. I was, however, told by an occupying farmer that the watercourse had quite dried up once in the last 14 years. I gauged the same stream higher up, to the east of Arnesby Lodge, within one field of the *Fleckney* parish boundary, and found the flow of 16,000 gallons not to have decreased. It is evident that the stream is fed by springs from Mr. Freer's land, and from the spring in the allotments at the

<sup>1</sup> 'Fleckney Water. Report to Market Harborough Rural District Council, 5th October, 1914.' *Privately printed*.

<sup>2</sup> *Ibid.*

<sup>3</sup> *Ibid.*

south-west corner of the Fleckney parish. I gauged 8,000 gallons a day from Mr. Freer's land, . . . " The *Shearsby Brook*, which passes under the Leicester old turnpike road near the 9th milestone to the north of Shearsby, was quite dry in July, 1914 (H. G. Coales).

The *River Wreak* is the principal tributary of the Soar and is a stream of considerable size on reaching the parent river near Cossington some five miles to the north of Leicester. It has its origin in springs from the Marlstone at Goadby Marwood, four and a half miles N.N.E. of Melton Mowbray. At Melton Mowbray the Wreak is joined by its chief tributary the *River Eye*. The River Eye above Saxby, its tributary the *Ashwell Brook*, the *Twyford Brook* and its tributary the *Marefield Brook*, were investigated at one time in connexion with a search for an additional supply to Leicester (see pp. 134, 139).

The chief tributaries of the Soar on the west or left bank are the *Thurlaston* and *Rothley* (or *Anstey*) *Brooks*; but a number of streams of lesser magnitude have been investigated at one time or another as possible sources of public supplies.

The water of the *Lubbesthorpe Brook* was once analysed in connexion with a search for a public supply to Enderby (see p. 40).

The *Rothley* or *Anstey Brook* discharges into the Soar near Rothley. In J. B. Everard's report on possible sources of an additional supply to Leicester (see p. 135) a gathering ground was mentioned at Bagworth Moats, Bagworth. The Thornton Reservoir (Leicester Corporation Waterworks) impounds the water of a tributary stream near by. Another site that was mentioned by Mr. Everard where a reservoir impounding the drainage of some 3,060 acres could be constructed was at Groby, where there is also the largest natural sheet of water in Leicestershire—Groby Pool.

A stream that rises in Charnwood Forest above Bradgate Park, flows through the Park, and *via* Swithland and Quorndon into the Soar, has had reservoirs constructed on its course at Cropston and Swithland. The former reservoir was opened in 1870, the latter in 1896. When J. B. Everard reported in 1885 on possible sources of additional supply to Leicester he mentioned Ling Dale, Hall Gates, and Swithland as sites suitable for impounding reservoirs having collecting grounds of about 1,010,480 and 2,000 acres respectively above them. In 1896 the Swithland Reservoir was completed and into it flows the drainage of all three collecting grounds, as well as, when there is any, the overflow from the Cropston Reservoir.

The headwaters of the *Wood Brook* and *Black Brook* are impounded in the Nanpanton and Blackbrook Reservoirs respectively of the Loughborough Corporation (see p. 127).



## II.—WATER SUPPLIES OF RURAL DISTRICTS

In the following pages the map references after the place names are distinguishable thus :—numbers unenclosed refer to the one-inch New Series maps ; those in square brackets to the Old Series Geological one-inch maps ; those in curved brackets to the six-inch maps.

### ASHBY-DE-LA-ZOUCH RURAL DISTRICT

The geology of this district is shown on the Geological Survey maps, New Series, Sheets 141, 155. The district extends over a variety of formations: Coal Measures occur at the surface in the parishes of Blackfordby (but the village is on Lower Keuper Sandstone), Coleorton, Oakthorpe and Donisthorpe (villages extend over Coal Measures, 'Permian,' and Bunter), Staunton Harold, Swannington, and Willesley (Church and Hall on 'Permian'); Lower Keuper Sandstone (on which the villages are situate except Measham which is partly on 'Permian'), in the parishes of Appleby Magna, Chilcote, Measham, Normanton-le-Heath, Snarestone, Stretton-en-le-Field, Thringstone, and Worthington; Keuper Marl (overlying Carboniferous Limestone) on which is the village, in Osgathorpe parish; while Boulder Clay with under- and over-lying sand and gravel occurs in greater or lesser spreads in all the parishes. The villages of Heather, Ravenstone, and Sweptstone are on Glacial sand and gravel. A few houses in Snarestone parish and some forty-four in Sweptstone have water from the Hinckley Urban District Council's Snarestone Waterworks; about fifty houses and the new Council Schools in Swannington parish, Coalville Urban District Council's water; and Measham, Oakthorpe and Donisthorpe water from the works recently completed (1928) (see p. 24) by the Council. Otherwise the district is dependent on wells and a few small springs.

#### Appleby Magna—Maps : 155 ; (22 S.W., S.E., 28 N.W., N.E.)

This parish extends over the Lower Keuper Sandstone. It is dependent on springs and wells, the supply from which is said to be good.

Three borings have been made in search for coal in the parish :

- 1.—Bird's Gorse, Side Hollows. Site marked on map.
- 2.—White House Boring. Site marked on map.
- 3.—Appleby Hall [near Roe House].

Details of the above borings are given in the 'Coalfield Memoir,' pp. 333-335. A summary of these details is as follows :—

				Thicknesses in feet and inches					
				1.		2.		3.	
Soil	...	...	...	1	4			1	0
Trias <sup>1</sup>	...	...	...	477	1	578	6	608	6+
Coal Measures	...	...	...	240	8½	396	4		
				719	1½	974	10	609	6

<sup>1</sup> Including basal breccia where present.

**Bardon**—Maps : 155 ; (24 N.W., S.W.)

In this parish is Bardon Hill—the highest hill in Leicestershire (912 ft.). The only good spring in the parish is that issuing from the hill and is used by the Quarry Company.

**Blackfordby**—Maps : 141 ; (15 N.E., S.E.)

The greater part of the parish is on Coal Measures but the village is on Lower Keuper Sandstone from the base of which issues a strong spring. The Boothorpe Fault runs through the parish : in the upper portion of the Middle or Productive Coal Measures to the west of it are the Moira Grits. Particulars of the Littleworth Borings, at the north end of the parish in the Coal Measures, and of Blackfordby Pit, are given in the 'Coalfield Memoir,' pp. 261, 265, 266.

*Blackfordby Spring*.—This spring is situate near the chapel in the lower part of the village—at the bottom of the hill some 200 yards S.S.W. of the Church. It issues from the base of the Lower Keuper Sandstone ; has never been known to fail ; is good water ; and is used by practically the whole of the village. In the *Gentleman's Magazine* for 1813 (pt. ii, p. 209) it is remarked that the water "is never frozen in the hardest winter ; neither in the large reservoir which receives it from the rock, nor in the broad stream which runs thence down the village road."

**Chilcote**—Maps : 155 ; (22 N.W., S.W.)

This parish is on Lower Keuper Sandstone except for a very small tract at the northern end which is floored with Bunter.

*Chilcote Boring*.—Site marked on map about 165 yards west of the church, Details from Mr. Smallman, published in the 'Coalfield Memoir,' pp. 331, 332. see also pp. 63, 91, 102. Summarized account :—

				Thickness		Depth	
				Ft.	In.	Ft.	In.
Lower Keuper Sandstone	Soil	...	...	3	0	3	0
	...	...	...	102	0	105	0
Bunter	{ Sandstone and pebble beds ... }			599	8	704	8
	{ Clunch ... }						
Coal Measures (? lower part)	{ Sandstone and shale with ironstone beds ... }			224	4	929	0
	{ Grey sandstone ... }			27	6	956	6
? Millstone Grit	{ Conglomerate ... }			0	9	957	3
	{ Coarse sandstone with quartz pebbles ... }			1	8	958	11

Fox-Strangways says ('Coalfield Memoir,' p. 63) : "600 feet [of Bunter] were found in the borings at Chilcote," and also (p. 102) that the boring "apparently went through the lower part of the Coal measures without meeting with any coal seams. This would seem to imply that the productive Coal measures are here entirely absent, although this is not proved."

**Cole Orton**—Maps : 141, 155 ; (16 N.W., N.E., S.W., S.E.)

The northern portion of this parish is on Coal Measures ; the southern portion mainly on the here succeeding Lower Keuper Sandstone. The parish is dependent on wells and a few small springs.

*Leicestershire Colliery and Pipe Co., Ltd.*—Boring made to prove coal seams (finished September 12, 1922,) by, and information from Messrs. Le Grand, Sutcliffe & Gell, Ltd. Site about 80 yards W.-W.S.W. of School near B.M. 375.5. Six-inch Map, 16 N.E. Ht. above O.D., 370 ft.

Coal Measures—427 ft.

Water-level, 209 ft. down. Yield not tested.

**Heather**—Maps : 155 ; (23 S.W., S.E.)

Heather village is on Glacial sand and gravel overlying Lower Keuper Sandstone. A spring that yields a fairly steady and constant supply and is used by a number of people issues from the Sandstone alongside the road between the village and the railway station.

*Heather Brickyard Well.*—This brickyard displays :—Drift Gravel, the lower portion of the Lower Keuper Sandstone, 28 ft., and Coal Measures shales, seen 3 ft. The water, of which the analysis is given, came from a well that goes through the Sandstone into the Coal Measures, but—according to W. Keay—practically all the water comes from the Sandstone. By S. F. Burford, 10.5.'24.

Appearance in 2-ft. tube						Parts per 100,000
Odour	...	...	...	...	...	Clear, colourless
Reaction	...	...	...	...	...	None
Metals	...	...	...	...	...	Faintly alkaline
Chlorine	...	...	...	...	...	None
Nitrites	...	...	...	...	...	2.1
Nitrogen as nitrates, etc.	...	...	...	...	...	None
Ammonia	...	...	...	...	...	None
Albuminoid ammonia	...	...	...	...	...	0.0012
Oxygen absorbed from permanganate in 15 min.	...	...	...	...	...	0.0078
at 80° Fahr.	...	...	...	...	...	0.0076
Total solids dried at 220°F.	...	...	...	...	...	55.0
Hardness (degrees, Clark's Scale)—						
Permanent	...	...	...	...	...	13.5
Temporary	...	...	...	...	...	8.5
Total	...	...	...	...	...	22.0
Microscopical examination of deposit	...	...	...	...	...	Earthy, numerous diatoms

*Remarks.*—This water is organically pure. It is hard and after filtering to remove suspended matters may be used for drinking and domestic purposes.

**Measham**—Maps : 155 ; (22 N.E., S.E., 23 N.W., S.W.)

Measham village is for the most part on 'Permian' breccia ; the extreme eastern portion on Lower Keuper Sandstone. Over The Fields, Measham, the 'Permian' is said to be from 25 to nearly 50 feet thick.

*Measham, Oakthorpe, and Donisthorpe Supply.*—These villages, since 1928, have been supplied from a well at Acresford—in the southern angle of the triangular piece of ground bounded by roads one mile S. by 50° W. of Donisthorpe. Information from J. P. Cook, Surveyor, Ashby-de-la-Zouch Rural District Council.

*Acresford Well.*—Sunk 1927. Ht. above O.D., 255 ft.

Well (70 ft., diameter 10 ft., with a 4-inch borehole 30 ft. deep) :

Lower Keuper Sandstone (basal portion)	...	} 100 ft.
Bunter	...	

At a depth of 50 ft. is a heading 15 ft. long by 6 ft. by 4 ft. Rest-level of water (18.I.'28), 12 ft. 4 in. down.

Yield 330,000 gallons per day. The water is pumped to a reservoir (capacity 100,000 gallons) near Home Farm, 1 $\frac{1}{16}$  mile N.N.E. of Measham Church.

*Public Well.*—At the top of Measham village, on the west side of the road almost opposite the Church, is a well (through 'Permian' into Coal Measures) 135 ft. deep with an average depth of water of 90 ft.



*Hinck's Close Well*.—320 yards east of Measham Church. Record by H. T. Brown, *Quart. Journ. Geol. Soc.*, vol. xlv, 1889, p. 11. Repeated in the 'Atherstone Memoir,' p. 30, and 'Coalfield Memoir,' p. 57.

	Thickness	Depth
	Ft.	Ft.
Red clay ... ..	9	9
Lower Keuper Sandstone ... ..	4	13
Clay parting ... ..	A few inches	
Breccia ... ..	3	16
Red marl, with brecciated fragments ...	18	34
Blue Coal-measures clay		

Fox-Strangways remarks in the Memoirs: "Mr. Brown calls the sandstone Lower Keuper, but there is no reason why it should not be of Permian age."

*Baptist Lane Spring*.—This spring is situate close to the canal (between the fault shown on the map and the lower limit of the 'Permian') a quarter of a mile W. 6°N. of Measham Church. It has never been known to fail and is used by people living in the neighbourhood.

### Oakthorpe and Donisthorpe—Maps: 155; (22 N.W., N.E., S.E.)

Both Oakthorpe and Donisthorpe villages extend over Coal Measures, 'Permian' breccia, and Bunter. Over the hill to the south of Donisthorpe the Bunter Pebble Beds are very conspicuous. One mile S.S.W. of the Church, Donisthorpe, on the west side of the barn on the gravel alongside the River Mease, is the Saltersford Boring. It passed through gravel, and Bunter sandstone and conglomerate, into the Coal Measures.<sup>1</sup>

Oakthorpe and Donisthorpe are now served by the new (1928) Measham, Oakthorpe and Donisthorpe Supply (see p. 24). In the 'Return as to Water Undertakings in England and Wales,' 1915, p. 453, it is stated that 12 houses in Oakthorpe and Donisthorpe, and, on p. 452, some houses in Ashby Woulds Urban District, are supplied by the Moira Colliery Co., Ltd., from (p. 255) "Spring from Triassic formation over Coal Measures, near Willesley Hall. The average daily quantity of water obtained is 5,000 gallons, and a further 5,000 gallons per day could be obtained. No filtration. Reservoir at Moira, 14,000 gallons. The daily average [quantity of water supplied] is 5,000 gallons. Supply is constant. [Quality of water] Pure." This supply, however, was discontinued some years ago, and neither the spring near Willesley, which issues from the Moira Grits in the Coal Measures, nor the reservoir at Moira is now in use. The Colliery Company has the public supply and town water is supplied to all their Moira houses, and from there they cart water on three days per week to the nine houses at Oakthorpe known as the 'Gin Stables.'

*Bramborough Terrace Well*.—This terrace, between the canal and Saltersford Brook,  $\frac{1}{8}$  mile E. by 25° S. of Donisthorpe Church, is served by a shallow well in Coal Measures which is well supplied with water. Locally it is held that the water finds its way into the well from the drowned-out "Who'd tho' it" Colliery (Oakthorpe Colliery).

### Ravenstone with Snibston—Maps: 155; (16 S.W., 23 N.W., N.E., S.W., S.E.)

*Snibston Colliery*.—1.—No. 1 Pit, sunk by George Stephenson in 1831 No. 4 of Sheet 19 of the Vertical Sections of the Geological Survey. Ht. above O.D., 510 ft. A detailed section from the Rev. W. Coleman's MSS. is given in the 'Coalfield Memoir,' pp. 271-273. Information as to yield of water from W. Keay. The shaft (9 ft. in diameter) was filled in but re-opened to a depth of 252 ft. by Messrs. Stapleford, who pump about 50,000 gallons a day to a large cast-iron tank on a tower.

<sup>1</sup> For records see 'Coalfield Memoir,' pp. 236-238.

2.—No. 2 Pit. No. 3 of Sheet 19 of the Vertical Sections of the Geological Survey. Ht. above O.D., 510 ft. Details, down to the Main Coal from G. Vaughan, February 25, 1855; and below, from the Rev. W. Coleman's MSS.

Summarized sections :

	(1)		(2)	
	Thickness Ft. In.	Depth Ft. In.	Thickness Ft. In.	Depth Ft. In.
Soil and clay (Boulder Clay)	5 0	5 0	17 6	17 6
Keuper Marl and sandstones	161 7	166 7	150 2	167 8
Whinstone ... ..	21 9	188 4	Absent	Absent
Coal Measures ... ..	490 8	679 0	595 7½	763 3½

Pit No. 1 is bricked from the surface to a depth of about 72 ft. and then tubed to 248 ft. 6in.

*First* 'spring' issues about 72 ft. down.

*Second* " " 180 ft. "

*Third*<sup>1</sup> " " 216 ft. "

Two sets of three throw pumps. On April 12th and 13th, 1905, the water became much discoloured and the smell was very offensive. This was thought to be due to the 72-ft. plug being out. The plug having been inserted, the water was much clearer on date of visit (by W. Keay) on April 14th, 1905, and had no smell.

**Snarestone**—Maps : 155 ; (22 S.E., 23 S.W., 28 N.E., 29 N.W.)

Snarestone village is on the Lower Keuper Sandstone. Half a mile N.N.E. of the village is the Pumping Station of the Hinckley Urban District Council's Waterworks (see p. 111) and therefrom three out of the eighty-four houses in the parish are supplied.

Two borings have been made in search of coal in the parish :

1.—No. 1 Boring near the turnpike south of the brook and east of the road from Snarestone to Measham, 1878. According to J. P. Cook (23.1.'28) a good 'spring' flows out from this borehole.

2.—No. 2 Boring near the Aqueduct, Bosworth Road. 1878.

Full details are given in the 'Coalfield Memoir,' pp. 335-342.

A summary of these details and (3) of the shaft and borehole at the Pumping Station is as follows :

	Thickness in feet		
	(1)	(2)	(3)
Soil ... ..	1½	1½	1½
Lower Keuper Sandstone and Bunter	152	207¾	221½
Coal Measures ... ..	322½	413¾	643½
	<hr/> 475½	<hr/> 622¼	<hr/> 866½

See also p. 111 of this memoir.

**Staunton Harold**—Maps : 141 ; (9 S.W., S.E., 16 N.W., N.E.)

The southern part of this parish is on Coal Measures which are faulted against the Upper Limestone Shales and Millstone Grit by the Staunton Harold Fault. In the north-eastern portion of the parish Lower Keuper Sandstone succeeds the Millstone Grit. Particulars of borings in the Coal Measures near Rough Heath Wood are given in the 'Coalfield Memoir,' pp. 317-320.

<sup>1</sup> In No. 1 Pit between 209 ft. 3 in. and 228 ft. 7 in. is 'gray metal stone.' See 'Coalfield Memoir,' p. 271.

**Swannington**—Maps ; 141, 155 ; (16 S.E., 23 N.E.)

The northern part of the parish is on Coal Measures ; the southern part on the succeeding Lower Keuper Sandstone and Keuper Marl. Some 50 houses out of about 427 houses in the parish, and the new Council Schools, are supplied by the Council with water obtained in bulk from the Coalville Urban District Council.

**Swepestone**—Maps : 155 ; (23 N.W., S.W., 29 N.W.)

Swepestone village is on Glacial sand and overlying Lower Keuper Sandstone. 44 out of 157 houses in the parish are supplied by the Hinckley Urban District Council from their waterworks at Snarestone.

*The United Dairies (Wholesale) Ltd.*<sup>1</sup>—On the east side of the road from Swepestone to Newton Burgoland one quarter of a mile S.S.E. from the church, Swepestone.

Boring made by, and information from Messrs. C. Isler & Co., Ltd.

				Thickness	Depth
				Ft.	Ft.
	Made ground	...	...	5	5
[Boulder Clay]	Clay and pebbles	...	...	23	28
[Keuper Marl	Marl and sandstone	...	...	112	140
and	Red shale	...	...	23	163
Lower Keuper	Sandstone	...	...	13	176
Sandstone]	Shale	...	...	10	186
	Marl and sandstone	...	...	36	222

45 ft. of 6-in. tubing, top 2 ft. down. Water-level 36 ft. down.

*Swepestone Large Field Boring.* Trial boring for coal from 100 to 500 yards S.E. of Clock Mill.<sup>2</sup> From the Rev. W. Coleman's MSS., and published in the 'Coalfield Memoir,' pp. 252, 253.

				Thickness	Depth
				Ft. In.	Ft. In.
	Soil	...	...	1 0	1 0
	Red clay	...	...	5 6	6 6
	Sand and marl	...	...	7 6	14 0
[Lower	Rock	...	...	3 0	17 0
Keuper	Sand and marl	...	...	8 6	25 6
Sandstone]	Sand rock	...	...	4 0	29 6
	Sand and marl	...	...	20 0	49 6
	Red marl	...	...	41 2	90 8
	Sand rock	...	...	7 4	98 0
	Bind	...	...	6 2	104 2
	Grey bind	...	...	2 6	106 8
	Blue bind	...	...	7 11	114 7
	Dark bind	...	...	1 11	116 6
	Black smut	...	...	3 0	119 6
	Clot	...	...	0 6	120 0
	Dark bind	...	...	9 6	129 6
	COAL	...	...	2 2	131 8
	Clot	...	...	0 10	132 6
	Blue bind	...	...	11 0	143 6
[Coal	Lightstone	...	...	2 0	145 6
Measures]	Cank	...	...	1 1	146 7
	Lightstone	...	...	1 5	148 0
	Light bind	...	...	4 0	152 0
	Black bind	...	...	7 0	159 0

<sup>1</sup> Formerly Edwards Creameries.

<sup>2</sup> Clock Mill is the mill shown on the one-inch Geological Survey Map on the stream south-east of Measham Hall.



## LEICESTERSHIRE WELLS

					Thickness	Depth
					Ft. In.	Ft. In.
[	Clot	...	...	...	1 8	160 8
	Stone	...	...	...	0 4	161 0
	Clot	...	...	...	4 2	165 2
	Black smut	...	...	...	0 3	165 5
	Shale	...	...	...	1 0	166 5
	COAL	...	...	...	3 9	170 2
	Light clunch	...	...	...	1 4	171 6
	Blue bind	...	...	...	2 0	173 6

## BARROW-ON-SOAR RURAL DISTRICT

The 'solid' rock which floors nearly the whole of this district is the Keuper Marl on which are situate the main parts of the villages of Newtown Linford, Ratcliffe-on-the-Wreak (Upper Keuper Sandstone) Swithland, Thurcaston, Ulverscroft, and Woodhouse. The small portions of the district that are not floored with this 'solid' rock are (1) the eastern portion, in which are Barrow-on-Soar, South Croxton, and Beeby—which has for its 'solid' floor Lower Lias; and (2) in the western portion, in the vicinities of Charnwood Forest and Mount Sorrel, where Pre-Cambrian rocks and granite respectively project through the mantle of Keuper Marl.

The 'solid' rocks are widely strewn with Superficial Deposits—principally Boulder Clay with associated Glacial sand and gravel. Villages for the most part on Boulder Clay are Anstey, Cropston, Leicester Frith, Seagrave, and South Croxton; and on the sand and gravel, Barkby Thorpe, Birstall, Rearsby, and Walton-on-the-Wolds.

The River Soar and the lower reaches of its principal tributaries are flanked, back of their margining alluvial flats, with river gravel which forms terraces. This river gravel, on account of its contained water being easily obtainable by shallow wells, was selected for the site of many a village—for example, Barkby, Cossington, Thrussington and Wanlip.

Apart from river gravels and Glacial sand and gravel, water-bearing beds may be said to be absent from the district. The usual unsatisfactory condition of shallow well waters in closely inhabited areas together with the absence of reasonably-accessible deeper-seated sources of supply has led to Leicester City Council water being introduced into many of the villages; it is now available in 20 out of the 29 parishes, namely, Anstey, Anstey Pastures, Barkby, Barrow-upon-Soar, Beaumont Leys, Birstall, Cossington, Cropston, Gilroes, Leicester Frith, Mountsorrel, Newtown Linford, Rothley, Seagrave, Sileby, Swithland, Syston, Thurcaston, Wanlip, and Woodhouse.

**Anstey**—Maps: 156; (25 S.W., 31 N.W.)

*Papermill Company*.—North side of village. Ht. above O.D., 225 ft. *Rep. Brit. Assoc. for 1875* (1876), p. 137; C. E. De Rance, *Trans. Manchester Geol. Soc.*, vol. xv, 1878, p. 96; 'Leicester Memoir,' p. 91.

Shaft (102 ft., diameter 8 ft.; bore, 85 ft., diameter, 3 in.):

		Thickness Ft.	Depth Ft.
[Drift]	Stiff brown Boulder-clay with many rounded pebbles [with lumps of black clay (shale) and pyrites] ... ..	70	70
[Keuper Marl]	Red marl with layers of gypsum (6 inches to 12 inches) and white and blue clay ( <i>dacey</i> ). [Another account gives 80 feet red marl and 10 feet skerry] ... ..	117	187
No water ; bottom of bore in gypsum.			

### Beaumont Leys—Maps : 156 ; (25 S.W., 31 N.W.)

*Beaumont Leys Boring.*—A boring was made in 1901, in search of coal, a quarter of a mile S.E. by E. of Beaumont Leys (site shown on Geological Survey Map (New Series), Sheet 156), but was abandoned before it had attained to any great depth.<sup>1</sup>

### Beeby—Maps : 156 ; (26 S.W., 32 N.W.)

*Beeby Brewery.*—Made for the Midland Brewery Co. by, and information from Messrs. C. Isler & Co., Ltd. 1896. Section published in 'Leicester Memoir,' p. 90 ; additional information in square brackets.

		Thickness Ft.	Depth Ft.
	Dug well ... ..	27	27
	Boring :—		
[Lower Lias]	Blue Lias with stone ... ..	91	118
	Rock and Blue Lias ... ..	5	123
	Blue Lias ... ..	17	140
	Hard rock ... ..	2	142
[Rhaetic]	Blue Lias ... ..	33	175
	Rock ... ..	4	179
	Black shale ... ..	8	187
	Red marl ... ..	5	192
[Keuper Marl]	Red marl with gypsum ... ..	6	198
	Red marl ... ..	5	203
	Red marl and shale ... ..	5	208
	Red and blue marl ... ..	50	258
	Rock ... ..	4	262
	Rock and red marl ... ..	3	265
	Hard rock ... ..	2	267
	Red and blue marl ... ..	3	270
	Red marl and rock ... ..	15	285
	Hard red marl ... ..	6	291
	Hard rock ... ..	1	292
	Hard red marl ... ..	16½	308½
	[Omitted] ... ..	66½	—
	Hard rock ... ..	2	375
	Hard red marl ... ..	15½	390½

Lined with 280 ft. of 6-inch tubes, top 9 ft. down.

Water-level (standing), 15 ft. down ; supply obtained 360 gallons per hour.

### Cossington—Maps : 142, 156 ; (18 S.E., 25 N.E., S.E.)

*Ratcliffe R.C. College.*—In quadrangle. 1843. Ht. above O.D., 312 ft.

<sup>1</sup> Browne, Montagu, *Trans. Leicester Lit. and Phil. Soc.*, vol. vii, pt. i, 1902, p. 6.

Rev. P. Hutton per James Plant, *Rep. Brit. Assoc. for 1878 (1879)*, p. 387 ;  
 'Leicester Memoir,' p. 91.

Well, 156 ft. ; diameter, 6 ft. Water stands at 8 ft.

In the 'Leicester Memoir,' p. 91, it is stated :—

"There is no detailed section given, but the nature of the rock is stated to be 'Lower Lias and Upper Keuper Marls and sandstone.' This is erroneous, as shown by information obtained by the college authorities in 1893, and kindly communicated to us per the Rev. J. Cappela. In this year the well was repaired, and samples of the strata taken at about every 11 feet, with the following result :—

		Ft.
[Drift]	Clayey sand with small pebbles and specks of chalk	At 11
	Clayey sand with small pebbles and specks or rather coarser ... ..	33
	Grey clay, probably dark when wet ... ..	44
	Gritty and with clayey partings and small stones ... ..	55
	Grey (blue) clay with sandstone, chert, etc. ... ..	66
	Grey (blue) clay with chalk, etc. ... ..	77
	Coarse sand, with fragments, little marl ... ..	88
[Keuper]	Red marl with a grey patch ... ..	99
	White quartzose sandstone ... ..	102
	Red marl streaked with grey ... ..	110
	Red sandy marl with gray specks ... ..	121

"From the above it will be seen that there is no Lias or Rhaetic in this well, as stated in the Report, but the strata passed through might be correlated according to the following summary.

Boulder-clay with a parting of sand, and possibly a bed of sand at the base ... ..	Ft. 88
Red marl with a bed of sandstone, probably the same as that which crops out in the village ... ..	68
Total depth ... ..	156

"Mr. G. Hodson states that this well, which was 139 feet deep, was continued by boring to 241 feet ; the Waterstones being reached at 220 feet."

**Swithland**—Maps : 156 ; (24 N.E., 25 N.W., S.W.)

*Wood Farm*.—On west side of wood.

Well through red [Keuper] marl to [Pre-Cambrian] slate, 36 ft. Information from Mr. Smith, well-sinker.

**Syston**—Maps : 156 ; (25 N.E., S.E., 26 S.W.)

*Railway Pumping Station*.—'Leicester Memoir,' p. 89. Well in sand and gravel [River Gravel], 18 ft., clay [Upper Keuper Marls], 12 ft.

**Ulverscroft**—Maps : 155 ; (24 N.W., N.E., S.W., S.E.)

*Bawdon Castle*, well at. Information from G. Dobdon, June, 1914.

Pre-Cambrian rock ... .. 70 ft.

Result.—No water.

*Bawdon Castle Farm*, two wells near. Sunk May, 1915, by Mrs. Herrick's Agent on the advice of a water finder, but both wells proved abortive. Information from W. Keay.

No. 1.—500 ft. N.W. of the farm :



		Thickness Ft.	Depth Ft.
[Superficial Dep.]	Loose earth and stones ... ..	25	25
[Pre-Cambrian]	{ Coarse grit ... ..	5	30
	{ Solid Black Brook rock—a very		
	{ fine hornstone ... ..	30	60
	{ Banded fine grit ... ..	50	110
No. 2.—300 ft. east of No. 1 :			
[Superficial Dep.]	Boulders and a little marl ...	9	9
[Pre-Cambrian]	{ Very coarse grit of the Black-		
	{ brook ... ..	10	19

**Wanlip**—Maps : 156 ; (25 S.W., S.E.)

*Wanlip Hall*.—1904. Ht. above O.D., 108 ft.

Boring made by, and information from, Messrs. Le Grand, Sutcliff & Gell, Ltd.

		Thickness Ft.	Depth Ft.
[Alluvium]	{ Top soil ... ..	2	2
	{ Peat ... ..	1	3
[River Gravel (terrace)]	{ Boulders ... ..	2	5
	{ Large gravel ... ..	2	7
[Keuper Marl]	Red and blue marl ... ..	4	11

Boring (6-inch tubing) made to allow weak supply to accumulate.

Water-level, 5 ft. down ; yield 40 gallons an hour.

**Woodhouse**—Maps : 141, 155, 156 ; (17 S.W., S.E., 18 S.W., 24 N.W., N.E., 25 N.W.)

'*Herbert's Well*.'—Well at S. F. Herbert's house on the Beacon Road (52 chains due west of 'The Windmill'). 1918.

		Thickness Ft. In.	Depth Ft. In.
Superficial Deposits	{ Soil and rock debris ('run of the hill') ... ..	17 0	17 0
	{ Mixed with sandy clay (yellowish sand) ... ..	1 2	18 2
	{ Red marl rather purple in colour and containing stones ... ..	5 0	23 2
Upper Keuper	{ Skerry containing large lumps of 'Forest Rock' [Pre-Cambrian] : not penetrated ... ..	1 7	24 9

2 ft. of water ; quality 'excellent' (S. F. Burford).

ANALYSIS						Parts per 100,000
Date ... ..	...	...	...	...	...	16.10.18
Appearance in 2-ft. tube ... ..	...	...	...	...	...	Turbid
Odour... ..	...	...	...	...	...	None
Reaction ... ..	...	...	...	...	...	Neutral
Chlorine ... ..	...	...	...	...	...	1.15
Nitrites ... ..	...	...	...	...	...	None
Nitrogen as nitrates, etc. ... ..	...	...	...	...	...	None
Ammonia ... ..	...	...	...	...	...	0.0016
Albuminoid ammonia ... ..	...	...	...	...	...	0.0131
Oxygen absorbed from permanganate in 15 min. at 80° Fahr. ... ..	...	...	...	...	...	0.0425
Total solids dried at 220° Fahr. ... ..	...	...	...	...	...	35.0
Hardness (degrees of Clark's Scale) ... ..	...	...	...	...	...	10.0
Microscopical examination of deposit ... ..	...	...	...	...	...	Sandy

## BELVOIR RURAL DISTRICT

The District, as regards land relief, is divisible into two parts—an Upland and a Vale. The Vale—the Vale of Belvoir—is on Lower Lias and in it are situate the villages of Bottesford, Muston, Redmile, Barkestone and Plungar. Bottesford is on Alluvium (overlying Lower Lias) beside the River Devon; the other villages mostly on the narrow outcrop of the Ferruginous Limestone Beds that occur in the Lower Lias. Borings in the Lower Lias in search of any considerable supplies would be unlikely to result in success; the Ferruginous Limestone Beds appear to be the best proved source of limited supplies, as indicated by the occurrence on or near their outcrop of the villages named.

The Upland portion of the district is composed, in ascending order, of Middle Lias (Sandy Clays succeeded by Marlstone or, as it is better known in this district, 'Ironstone'), Upper Lias (clay), Northampton Beds (with basal ferruginous sands), and Lincolnshire Limestone. On it are situate Belvoir and Knipton (in a valley), Harston and Croxton Kerrial. The horizons for springs are (1) at the base of the Marlstone, and (2) at the base of the Northampton Beds from which they are thrown out by the underlying Upper Lias clay.

The villages in the Vale are supplied by shallow wells, those in Bottesford being shallower than in the other villages. Belvoir, Knipton, Croxton Kerrial and Harston are provided for partly by piped supplies from springs and partly by wells. The supplies from wells in the district are said to be sufficient and good.

The River Devon is held by some to rise in Croxton Park. The Croxton sewage passes through a filter bed, the effluent runs into a dyke, and after two miles of natural filtration enters the River Devon at Knipton. At Knipton the Devon receives the overflow of the septic filter beds there. "The sewers of Muston, and a small proportion of those at Bottesford pass directly into the River. At Bottesford there is a main sewer which follows the course of the main road from Grantham to Nottingham, and at the west end of the village it is open and runs as such for two miles to the boundary of the district. The solid matter is removed from this open sewer when necessary. The main sewer is flushed frequently from the River Devon."<sup>1</sup>

**Barkestone**—Maps : 126, 142; (2 S.W., S.E., 7 N.W., N.E.)

The village is on Lower Lias—for the most part just above the outcrop of the Ferruginous Limestone. It is dependent on wells, the majority of which are fitted with pumps.

**Belvoir**—Maps : 142; (7 N.E.)

The houses composing the village are somewhat scattered—the majority are on the Lower Lias, a few near the junction of this subdivision with the

<sup>1</sup> 'Annual Report of the Medical Officer of Health for the year 1925,' Belvoir Rural District Council. Page 6.

Middle Lias. Near Blackberry Hill a spring issues from the base of the Ironstone (Marlstone): it is a useful but not a large spring.

Many of the houses in the parish, in Belvoir village, are served by an undertaking belonging to the Belvoir Estates, Ltd., with source of supply a spring issuing from the Northampton Sand near the inn three-eighths of a mile S. 15°W. of Croxton Kerrial Church (see also Knipton). Houses not so served are dependent on wells.

*Belvoir Spa.*—As is so frequently the case water in the clays in the upper part of the Lower Lias of this District has been found to be locally saline. For some time there was a Spa at Belvoir: it is marked on the Old Series Geological Survey Map, Sheet 70. Now nothing remains of it, but its site is just inside the wood on the north side of the road half-a-mile N.W. by W. of Bevoir Castle. The water was a saline water and was obtained from a well in—as in the case of the Cheltenham waters—the Lower Lias. The writer has been informed that there used to be a well at the keeper's old house (now demolished) to drink saline water from which a woman—within the recollection of people still living—used to walk over regularly from Redmile. The site of the keeper's old house is just outside the western corner of the wood and only a few yards to the north-west of the position assigned to the Spa on the Old Series Geological Survey map.

**Bottesford**—Maps: 126; (1 S.E., 2 N.E., S.E., 7 N.E.)

The village is on red pebbly sand (overlying Lower Lias) beside the River Devon. It is dependent on shallow wells.

**Croxton Kerrial**—Maps: 142, 143; [70]; (7 S.E., 8 S.W., 13 N.E., 14 N.W.)

The village has a piped service, the property of Belvoir Estates, Ltd., but there are also pumps. The source of supply of the piped service is a spring issuing from the Northampton Sand, from which it is thrown out by the Upper Lias clay, in a paddock belonging to the Peacock Inn, Croxton Kerrial, at a quarter of a mile S.W. by S. from the church. The water is raised by a ram to three tanks from which it gravitates. The spring is more than sufficient for local requirements and a good streamlet flows continuously down the valley side into the River Devon.

A good spring issues from the base of the Northampton Beds, from which is it thrown out by the underlying Upper Lias clay, near the site of the Abbey in Croxton Park.

**Harston**—Maps: 143; [70]; (8 N.W., S.W.)

The village is situate on the Ironstone (Marlstone). The lower part of the village is satisfactorily supplied by wells fitted with pumps—private and public; the upper part has a piped service from the Stanton Ironworks Co.'s Supply. The source of the piped service is a good spring from the Marlstone situate about three-quarters of a mile N.E. by N. from Harston Church. There is a good spring near Blackwell Lodge issuing from the Northampton Sand.

**Knipton**—Maps: 142, 143; [70]; (7 N.E., S.E., 8 S.W.)

The village is partly on Glacial sand and gravel and partly on the sandy clays of the Middle Lias. It is supplied (public taps) by an undertaking belonging to the Belvoir Estates, Ltd. The source of supply is a spring from the base of the Marlstone (or Ironstone) near the 300-ft. contour-line a quarter of a mile S. 28°E. of Knipton church. The Belvoir Supply, conveyed by pipes, is available for Knipton if the Knipton supply is at any time insufficient.

Knipton Reservoir, of which a part is in this parish, is a feeder of the Grantham Canal.



**Muston**—Maps : 126, 127 ; [70] ; (2 N.E., S.E., 3 N.W., S.W.)

The village is on the Ferruginous Limestone Beds in the Lower Lias and is dependent on shallow wells.

**Plungar**—Maps : 142 ; (7 N.W., N.E., S.E.)

The village is partly on the Ferruginous Limestone Beds and partly on the beds immediately below. It is dependent on shallow wells, the majority of which are fitted with pumps.

**Redmile**—Maps : 126, 142 ; (2 S.W., S.E., 7 N.E.)

The village is similarly situated, from a geological standpoint, to Plungar and, like Plungar, is dependent on shallow wells.

#### BILLESDON RURAL DISTRICT

This Rural District extends eastwards from the County Borough of Leicester and the Urban Districts of Oadby and Wigston Magna to the county boundary between Withcote and Allexton and the boundary of the Hallaton Rural District to the south.

The portion of the district nearly as far eastwards as a line joining the villages of Owston, Tilton-on-the-Hill, and Goadby is in the vale ; that beyond this line on the undulating hill-country. The vale has for its 'solid' rock-floor Lower Lias, but this clay formation is for the most part covered with Glacial deposits. These Glacial deposits consist of Boulder Clay with associated sand and gravel which is most in evidence at two horizons—in the Boulder Clay and at its base (between the Boulder Clay and Lower Lias), but that at its base is generally the thicker deposit. Villages on the Boulder Clay are very few in number and very small on account of the inadequacy of the supplies to be obtained from the Boulder Clay. Nearly all the villages—for example, Burton Overy (partly on Boulder Clay), Rushby, Carlton Curlew, Evington, Frisby, Galby, Houghton-on-the-Hill, Humberstone, Hungerton (partly on Boulder Clay), Keyham, King's Norton, Lowesby (partly on Boulder Clay), Rolleston, Scraftoft (church on sand and gravel, village on overlying Boulder Clay), Stoughton, Stretton Parva, Thurnby—are situate on small tracts of the sand and gravel. It is useless to search for water by means of borings into the Lower Lias. A boring at Billesdon proved the Lower Lias to be over 700 feet thick there ; one at Ingarsby Station, 115 ft. deep, failed to yield water ; and it is likely that if a little water were obtained it would be saline and possibly impregnated with sulphuretted hydrogen.

The hill-country is composed, in descending order, of

Upper Lias    Principally clay—impermeable ;

    Middle    { Marlstone—water in fissures,

    Lias       { Clays and sands ('Sandy Beds')—water in sandy layers,

but Glacial deposits, similar to those in the vale, over-spread considerable portions of these 'solid' formations.

As in the vale, there are villages—for example, Halstead, Owston, Rolleston, Skeffington, Tilton-on-the-Hill, and Tugby

(partly on Boulder Clay)—which are located on Glacial sand and gravel.

The Middle Lias is a useful aquifer when the demand is for a small supply. Water is to be met with issuing from and in the sandy layers in the lower portion of the Middle Lias, and villages dependent partly or entirely on supplies from this source are Allexton, Billesdon and Noseley. Farther north, in the Melton Mowbray Rural District, the Marlstone carries useful supplies of water in its fissures. In this district the Marlstone is thinner, but the fact that East Norton, Goadby, Launde, Loddington, and Withcote, are located on it demonstrate that it is water-bearing.

The Upper Lias is scantily populated as is to be expected in view of its clay and non-aquiferous nature.

Springs are to be met with mostly issuing from the Glacial sand and gravel; also from the sandy layers in the lower portion of the Middle Lias, and from the base of the Marlstone. Locally, as at Houghton-on-the-Hill, springs from the Glacial sand and gravel are slightly chalybeate, and—although there is no information on the matter—springs from the Middle Lias might be expected to be slightly chalybeate for the Marlstone is ferruginous.

W. D. Waine, Sanitary Inspector to the Council, informs me that he does not know of any springs in the district, not at present used for the purpose of a supply, that are worth mentioning.

Parts of the parishes of Bushby, Evington, Humberstone, Thurnby and Scraptoft are supplied with Leicester water: in Evington and Humberstone hundreds of new houses are thus supplied.

**Billesdon**—Maps: 156; (32 S.E., 38 N.E.)

*Billesdon Boring*.—Site marked on map in the valley near the brook below Frisby. Made by, and information from, Messrs. Thompson Bros. 1897. 'Leicester Memoir,' p. 88.

				Thickness	Depth
				Ft.	Ft.
[Lower Lias and ?Upper Rhaetic]	Surface soil	...	...	3	3
	Clay and stones	...	...	16	19
	Lias (weathered)	...	...	125	144
	Lias (firm) [ <i>Amm. bonnardi</i> at 240 ft.]	...	...	348	492
	Lias with thin limestone beds	...	...	114	606
	Lias dark (no lime)	...	...	33	639
	White limey sandstone [effervesces strongly]	...	...	9	648
	Light fireclay	...	...	3	651
	Dark and broken flakes [shaly sandstone]	...	...	10	661
	Brown dun [clay]	...	...	12	673
	Dark flakes and braes [shale]	...	...	38	711
	Dark shaly braes [with <i>Pteria contorta</i> ?]	...	...	5	716
	Blue marl [Tea-green Marl]	...	...	15	731
	Marly sandstone with thin gypsum beds	...	...	238	969

*Billesdon Coplow Boring*.—Site indicated on the map.

Abstract of account of boring by J. Holdsworth, *Phil. Mag.*, ser. 3, vol. iii. 1833 p. 77<sup>1</sup>, published in 'Leicester Memoir,' p. 88.

	Thickness Ft.	Depth Ft.
[Lower Lias] { Strong slaty bind, containing about 9 feet of excellent ironstone in beds from 3 inches to 10 inches thick ... .. 150 150	150	150
Dun marl or bands of freestone, alternating in layers from 1 inch to 3 inches thick ... .. 30 180	30	180
Grey rock ... .. 27 207	27	207
Hard grey or freestone bands, divided by thin bands of light blue and black shale, with two thin veins of coal ... .. 120 327	120	327
Hard bastard dun, much impregnated with coaly matter ... .. 42 369	42	369
Very hard striped rock ... .. 2½ 371½	2½	371½
Red dun, or, rather, shale ... .. 9 380½	9	380½
Rock beautifully striped with black, white, brown, and dun... .. 21 401½	21	401½
Brown dun ... .. 18 419½	18	419½
Strong black shale, occasionally finely striped with white ... .. — —	—	—
[?Total depth] ... .. 419½		419½

Fox-Strangways says<sup>2</sup> of this boring that it "... appears to have been left off in the Lias Shales which, however, were supposed to have been Coal-measures."

**Glen Magna**—Maps: 156, 170; [63 S.E.]; (37 S.E., 38 N.W., S.W., 45 N.W.)

The greater part of the village is situate partly on Lower Lias and partly on Alluvium bordering the River Sence. The church, however, is located on Boulder Clay and Hill Top on Glacial sand and gravel.

Glen Hall is partly on Boulder Clay and partly on sand and gravel. These Glacial Deposits rest on Lower Lias. The estate belongs to Lt.-Col. E. C. Packe. In the north-west corner of the grounds east of the Hall is a well 20 ft. deep, said to be in "blue clay" [Boulder Clay], the supply in which—which is used for the Hall—"has not been known to run low." Close to the west side of the road some 350 yards W. by S. of the Hall is a well 24 feet deep, in "blue clay" (?Alluvium and Lower Lias), the supply in which—which is used for two cottages made out of the old mill and the property of Lt.-Col. Packe—has likewise never been known to run low.

**Hungerton**—Maps: 156; (26 S.E., 32 N.W., N.E., S.W., S.E.)

*Ingarsby Railway Station*.—Communicated by J. L. Pattison, 1882, and published in 'Leicester Memoir,' p. 88.

Well (50 ft.) and boring (65 ft.) :—

	Thickness Ft.	Depth Ft.
Made ground ... .. 3 3	3	3
Blue clay and sandstone ... .. 4 7	4	7
Blue clay and stone ... .. 12 19	12	19
Sand and blue clay ... .. 1 20	1	20

<sup>1</sup> There is a criticism of this account by Conybeare, *Phil. Mag.*, ser. 3, Vol. iii. p. 112, a counter reply by Holdsworth, *Mag. Nat. Hist.*, vol. vii, 1834, p. 42.

<sup>2</sup> 'Coalfield Memoir,' p. 106.



					Thickness	Depth
					Ft.	Ft.
[Lower Lias]	Blue clay and limestone	...	...	...	4	24
	Sand	...	...	...	1	25
	Blue clay and stones	...	...	...	69	94
	Hard blue Lias stone	...	...	...	2	96
	Blue clay and stone	...	...	...	13	109
	Clay stones and pebbles	...	...	...	6	115

No supply ; rain-water has to be used at the station.

**Keyham**—Maps : 156 ; (32 N.W., S.W.)

*Upper Hall* (now Old Hall).—On Boulder Clay (Glacial) : (1) Well (by back door), 90 feet deep, water-level 70 feet down ; supply 'very good.' [Probably through Boulder Clay to Glacial sand]. (2) Well (in stable yard), 16 feet deep, in 'sandy loam or pockets [Glacial],' water-level 12 feet down ; supply good in quantity except in very dry weather, but impure from drainage pollution.

Information from J. A. L. Beasley, Leicester.

*Nether Hall*.—On sand and gravel (Glacial) : well [in Glacial sand and gravel].

ANALYSES

1.—Well in Boulder Clay, Keyham village. Supply nil.

					In grains per gallon
Chlorine	...	...	...	...	1·6
Equal to chloride of sodium (common salt)					2·6
Nitrites	...	...	...	...	trace
Nitrates (expressed as nitrogen)	...	...	...	...	0
Ammonia (free)	...	...	...	...	0·002
Ammonia (albuminoid)	...	...	...	...	0·018
Metals	...	...	...	...	Nil

Appearance in 2-foot tube :—Yellowish-green, turbid.

Smell when heated to 100°F.—nil.

Hardness : temporary, 10·3°, permanent, 48·3°.

"I do not consider the water suitable for drinking purposes in its present condition."

By Dr. Charles Cole, 28th September, 1900.

2.—Nether Hall, well at. In Glacial sand and gravel.

Appearance in 2-foot tube :—Clear, bright.

Smell when heated to 100°—none.

Microscopical examination :—No deposit, some carbonaceous matter.

					In grains per gallon
Oxygen absorbed in 2 minutes at 80°	...	...	...	...	·0071
Solids	...	...	...	...	35
Chlorine	...	...	...	...	1·1
Free ammonia	...	...	...	...	·0017
Albuminoid ammonia	...	...	...	...	·0048
Hardness in degrees, 5·1.					

"This is a good water and fit for all domestic purposes. Slight traces of iron, but no other metallic impregnation."

By Dr. N. L. Emmerson, 21st January, 1890.

**Scraptoft**—Maps : 156 ; (31 N.E., S.E., 32 N.W., S.W.)

Several houses in Scraptoft are supplied by pipe from a spring—from Glacial deposits—in front of the Hall. Owner, B. W. Cole.

**Tilton**—Maps : 156 ; (32 S.E., 33 S.W.)

A good spring issues from the Marlstone at half-a-mile N.W. of the church, Tilton, and is piped to Loesby Station. Another good spring issues from Glacial sands (on Upper Lias) at a quarter of a mile south-south-eastward of the church.

**Tugby**—Maps : 156 ; (39 N.W., S.W.)

Certain houses in the village are supplied by an undertaking belonging to W. A. North. The source of supply is a spring from the Marlstone (Middle Lias) situate  $1\frac{9}{10}$  miles S. by  $27^{\circ}$  E. from Tugby church (just below the space between the 'g' and 'e' of 'Lodge' of 'Keythorpe Lodge' on the map—1 inch Ordnance and Geol. Survey Maps, Sheet 156). Yield not known. No filtration. Reservoir in Middle Park, near Tugby, capacity not known. The quantity of water supplied is adequate and the quality good.

### BLABY RURAL DISTRICT

This Rural District has for its 'solid' rock Keuper Marl, except for : (1) the small south-eastern portion, in which are Countesthorpe, East Wigston, Foston, Glen Parva, and Kilby, which is on Lower Lias ; and (2) very small areas in Croft, Earl Shilton, Enderby and Huncote parishes which are on syenite. These 'solid' rocks are much obscured by extensive Glacial deposits consisting of Boulder Clay, gravel, and sand ; on the gravel and sand deposits are located many of the larger villages. Part of Narborough and practically the whole of Blaby is on river-gravel (terrace). It is generally easy to determine whether a site is on Superficial Deposits, for these are very distinct from the red Keuper Marl and blue Lower Lias clay.

Leicester Corporation water has been taken into all the parishes in the district except East Wigston, Foston, Kilby, Potters Marston, and Thurlaston. Some 104 out of 154 houses in Croft are supplied by an undertaking belonging to the Croft Granite, Brick and Concrete Co., Ltd.

There are no large springs in the district ; for small private supplies the Glacial sands and gravels are the only potential sources of supply. It is unlikely that deep borings in search of water in the district would prove satisfactory.

**Blaby**—Maps : 156, 170 ; [63 S.E.] ; (37 S.W., 44 N.W.)

*Blaby Isolation Hospital*.—About one mile S.E. of Blaby. Information from Messrs. Simpson & Harvey.

'Leicester Memoir,' p. 92.

Two wells, the one at the top of the field about 90 ft. deep ; the other at the side about 35 ft. deep :—

							Thickness	Depth
							Ft.	Ft.
Soil	...	...	...	...	...	...	0 $\frac{1}{2}$	0 $\frac{1}{2}$
Brick clay	...	...	...	...	...	...	20	20 $\frac{1}{2}$
Bluish clay with a vein or pocket of sand at 35 ft.							? 70	? 90 $\frac{1}{2}$

**Countesthorpe**—Maps: 156, 170; [63 S.E.]; (37 S.W., S.E., 44 N.W., N.E.)

*Cottage Homes Boring.* June, 1892.

'Leicester Memoir,' p. 93.

		Thickness		Depth	
		Ft.	In.	Ft.	In.
[Glacial]	Well [Drift] ...	87	0	87	0
	[Red marl] ...	16	0	103	0
	Boring (diameter, 4 in.) :—				
	Red marl ...	28	0	131	0
	Red marl and gypsum ...	6	6	137	6
	Marl and gypsum ...	41	6	179	0
	Sandstone ...	1	2	180	2
	Blue and red marl ...	9	10	190	0
	Slate and blue marl [skerry] ...	6	6	196	6
	Blue and red marl ...	3	6	200	0
	Red marl and gypsum ...	102	0	302	0
	Red marl ...	43	6	345	6
	Sandstone ...	3	0	348	6
	Red marl ...	8	6	357	0
	Sandstone ...	0	3	357	3
	Red marl rock ...	4	3	361	6
[Keuper]	Red marl rock ...	31	4	392	10
	Hard rock ...	0	6	393	4
	Red marl ...	83	2	476	6
	Rock ...	0	6	477	0
	Red marl ...	72	0	549	0
	Blue marl rock ...	2	6	551	6
	Red marl ...	46	6	598	0
	Red and blue marl and red sandstone ...	2	6	600	6
	Red marl ...	4	0	604	6
	Red sandstone ...	10	0	614	6
	Marl and blue sandstone ...	8	0	622	6
	Red marl ...	4	3	626	9
	Granite <sup>1</sup> ...	2	9	629	6
	Red marl ...	3	6	633	0
	Granite ...	4	8	637	8

Tubing remaining in borehole: 80 ft. of 5 in., top 39 ft. 6 in. below surface; 190 ft. of 4 in., top 152 ft. 6 in. below surface. No supply.

**Croft**—Maps: 155, 169; (36 S.E., 43 N.E.)

Croft village extends over syenite, Keuper Marl, and Glacial sand. Practically all the houses, except a few outlying farms, are supplied by an undertaking belonging to the Croft Granite, Brick and Concrete Co., Ltd.<sup>2</sup> The source of supply is a spring from a fissure in the syenite (which is locally overlaid by Keuper beds) at the bottom of the southern end of the quarry. The average daily quantity of water obtained is 100,000 gallons. The water is pumped to two reservoirs (total capacity, 32,000 gallons) on Croft Hill, one being used to supply the high level portions of the village.

James Plant recorded (*Rep. Brit. Assoc.* for 1882, p. 226) that the water was first struck on January, 1, 1882, and "has been running without ceasing for eight months. A pump is now used which discharges 100,000 gallons every ten hours. Quantity is the same as when first struck. [The spring] is below

<sup>1</sup> A fine grained felsitic rock; see 'Leicester Memoir,' p. 116.

<sup>2</sup> No houses are supplied outside Croft parish, this being the only area in which the Company is empowered to supply under the Croft Water Order dated 1903.



the level of the River Soar, which runs close by. No proper analysis yet made, but water very soft." Analysis has proved, however, that the water is very hard.

## ANALYSIS

By Messrs. Bostock, Hill & Rigby, Birmingham. 14.12.'20.

				Parts per 100,000
Saline and free ammonia	...	...	...	0.002
Albuminoid ammonia	...	...	...	0.008
Chlorine in chlorides	...	...	...	5.400
Nitrogen in nitrates and nitrites	...	...	...	0.440
Oxygen absorbed from permanganate at 80°F. in 4 hours	...	...	...	0.058
Total solids dried at 100°C.	...	...	...	156.000
Hardness: temporary	...	...	...	6.30
permanent	...	...	...	47.9
total	...	...	...	54.20

Appearance: Bright, few small particles.

*Remarks.*—Water submitted to bacteriological test, and number of organisms capable of growth at 20°C. quite low. There was no evidence of the presence of any organisms associated with animal excreta, and the water may, therefore, be considered quite satisfactory.

*The Gables.*—Well (by kitchen sink), in Boulder Clay, 19 ft. deep, water-level 16 ft. down. Supply poor: well now disused. Analysis by Dr. Charles Cole, 31.5.1901.

				In grains per gallon
Total solid matter	...	...	...	86.0
Chlorine	...	...	...	6.4
Equal to chloride of sodium (common salt)	...	...	...	10.5
Nitrites	...	...	...	Nil
Nitrates (expressed as nitrogen)	...	...	...	1.9
Ammonia (free)	...	...	...	.003
Ammonia (albuminoid)	...	...	...	.008
Metals	...	...	...	Nil
Appearance in 2-ft. tube: yellowish-green, slightly turbid.				
Smell when heated to 100°F.	...	...	...	Nil
Hardness: Temporary	...	...	...	11.8
Permanent	...	...	...	22.7

"Sample gives evidence of previous pollution with organic matter of animal origin and is unsuited for domestic use. The permanent hardness is also excessive."

**Enderby**—Maps: 155, 156; (36 N.E., S.E., 37 N.W., S.W.)

The village of Enderby is now supplied with water from Leicester. Before this supply, however, was laid on a search was made for a local source of supply and the following analyses were made:—

- 1.—Hopyard Farm, Lubbethorpe, spring supply to.
- 2.—Hopyard Farm supply, overflow from.
- 3.—Lubbethorpe Brook, overflow above footbridge.
- 4.—" " above overflow.
- 5.—Rabbit burrows.
- 6.—" "
- 7.—Roesrest Farm, West Leicester Forest.

By S. F. Burford.

		Grains per gallon.						
		1	2	3	4	5	6	7
Date ...	...	14.2.96	26.11.95	26.11.95	26.11.95	4.3.96	1.10.96	1.10.96
Appearance in 2-ft. tube ...	...	Clear, pale green tint	Clear, bright	Clear, bright brownish green	Turbid, brownish	Turbid, cloudy	Clear, almost colourless	Clear, almost colourless
Odour when heated		None	None	Faint	—	Earthy	None	None
Chlorine ...	...	1.37	1.47	1.07	1.57	1.35	1.02	1.02
Nitrites ...	...	None	None	None	Present	None	None	None
Nitrogen as nitrates, etc. ...	...	0.32	0.28	0.25	0.19	None	0.44	0.44
Ammonia ...	...	0.0002	0.0016	0.0016	0.1383	0.0079	0.0023	0.0023
Albuminoid ammonia ...	...	0.0100	0.0154	0.0235	0.0268	0.0141	0.0214	0.0214
Oxygen absorbed by organic matter in 15 min. at 80° Fahr ...	...	0.0128	0.0115	0.0527	0.2380	0.0851	0.0294	0.0294
Total solid matter dried at 220° Fahr. ...	...	40.6	39.2	26.6	35.7	35.7	14.0	14.0
Hardness (degrees of Clark's Scale) :—								
Temporary ...	...	0.5	1.5			13.0	1.0	0.5
Permanent ...	...	10.0	9.0	10.0		11.0	5.0	5.5
Total ...	...	10.5	10.5	10.0	11.0	24.0	6.0	6.0
Microscopical examination of deposit		Chiefly mineral Satisfactory	—	Very slight. Satisfactory	Vegetable matter	Earthy: a little vegetable matter	Desmids and diatoms	Desmids and diatoms

*Remarks :—*

- 1.—May safely be used for drinking and domestic purposes.
- 3.—May safely be used for drinking.
- 4.—Contaminated with drainage matters and unfit for drinking.
- 5 and 6.—Not fit for drinking.
- 7.—Cannot be recommended for drinking.

## ANALYSIS

Narborough Quarry<sup>1</sup> in the syenite, but Stockingford Shales (Cambrian) are exposed beneath the syenite in the bottom of the quarry. By S. F. Burford.

		Grains per gallon	
Date ...	...	...	1.10.1896
Appearance in 2-ft. tube ...	...	Brownish, slightly turbid	
Odour when heated to 100° Fahr. ...	...	Faint	
Chlorine ...	...	1.64	
Nitrites ...	...	None	
Nitrogen as nitrates, etc. ...	...	None	
Ammonia ...	...	0.0011	
Albuminoid ammonia ...	...	0.0013	
Oxygen absorbed by organic matter in 15 min. at 80° Fahr. ...	...	0.0171	

<sup>1</sup> This quarry is in Enderby parish.

					Grains per gallon
Total solid matter dried at 220° Fahr.	...	...	...	...	53.9
Hardness (degrees of Clark's Scale) :—					
Temporary	...	...	...	...	5.5
Permanent	...	...	...	...	24.5
Total	...	...	...	...	30.0
Microscopical examination of deposit					Earthy ; diatoms

*Remarks.*—This water may safely be used for drinking and domestic purposes.

**Glenfield**—Maps : 155, 156 ; (30 N.E., S.E., 31 N.W.)

*Glenfield Land Society.*—Estate on Boulder Clay. "Deepest well about 60 ft. Blue and red clay [Boulder Clay] 50 ft., sand [Glacial] below." Information from Mr. Smith, well-sinker.

**Glen Parva**—Maps : 156 ; (37 S.W.)

*The Barracks.*—Ht. above O.D., about 300 ft. Information from Messrs. Campbell per James Plant, *Rep. Brit. Assoc. for 1878* (1879), p. 387; 'Leicester Memoir,' 1903, p. 92.

Shaft (100 ft., diameter, 6 ft. ; bore, 150 ft., diameter, 6 in.) :—

					Thickness	Depth
					Ft.	Ft.
[Glacial]	Drift	...	...	...	10	10
[Lower Lias]	Lower Lias with thin limestone	...	...	...	40	50
[Rhaetic]	Rhaetic [mostly tea-green marl]	...	...	...	20	70
[Keuper Marl]	Chocolate marl	...	...	...	30	100
	Red marls, chocolate colour	...	...	...	150	250

Very little water ; that considered to be surface water ; and hard what there was.

**Kirby Muxloe**—Maps : 155 ; (30 S.E., 36 N.E.)

*Kirby Land Estate.*—At south-western end of Kirby Muxloe village.

"(1) Well in Moore's Plot, by junction of two roads in lowest corner [in Glacial sand and gravel], 10 ft. deep, water-level 7 ft. down, supply good.

(2) Well in How's Plot, higher up road [in Glacial sand and gravel] 30 ft. deep, water-level 26 ft. down, supply good."

Information from J. A. L. Beasley.

*Fox's Cottage.*—On west side of road west of Kirby Land Estate.

"Well [in Keuper Marl] 40 ft. deep, water-level 36 ft. down, supply good." Information from J. A. L. Beasley.

*Castledene.*—Well in Keuper Marl, 10 ft. deep, water-level 4 ft. down. Analysis by Dr. Charles Cole, 25.1.1896.

					In grains per gallon
Chlorine	...	...	...	...	3.7
Equal to sodium chloride (common salt)	...	...	...	...	6.1
Nitrites	...	...	...	...	Nil
Nitrates (expressed as Nitrogen)	...	...	...	...	3.5
Ammonia (free)	...	...	...	...	0.003
Ammonia (albuminoid)	...	...	...	...	0.028

*Remarks.*—"The water is a very bad one."

**Lubbesthorpe**—Maps : 155, 156 ; (36 N.E., 37 N.W., S.W.)

*Lubbesthorpe Cottages.*—Well No. 1 sunk at back of cottages behind out-buildings. 1901. Information from W. Keay.



					Thickness	Depth
					Ft.	Ft.
Glacial	{	Light drift loam	...	...	5	5
	{	Gravel	...	...	2	7
	{	Dark gravel	...	...	13	20

The water proved to be highly polluted.

**Narborough**—Maps : 155, 156, 169 ; (36 N.E., S.E., 37 S.W.)

Narborough village and the large County Asylum are supplied with water from Leicester.

*Narborough Wood House Boring.*—(Map 155) ; 6-inch boring. 1915. Information from W. Keay.

Boulder Clay	...	...	...	...	} 72 ft.
Upper Keuper Sandstone	...	...	...	...	
Keuper Marl	...	...	...	...	

Windmill-pump. A copious supply of water since June, 1915.

ANALYSIS

Total solids	...	...	...	...	Grains per gallon
					50.0
Free ammonia	...	...	...	...	Parts per million
					None
Albuminoid ammonia	...	...	...	...	0.05
					Grains per gallon
Nitrogen as nitrites and nitrates	...	...	...	...	0.041
Chlorine	...	...	...	...	1.0
Hardness (degrees)	...	...	...	...	11.5

By L. Ough, F.C.S.

**New Parks**—Maps : 156 ; (31 N.W., S.W.)

*Bird's Nest Cottage*, well at. 1908.

					Thickness	Depth
					Ft.	Ft.
Boulder Clay	{	Yellow clay	...	...	6	6
	{	Dark clay with fragments of chalk	...	...	9	15
	{	Lighter clay	...	...	10	25
	{	Dark clay	...	...	15	40
	{	Sandy clay	...	...	5½	45½

Diameter of well, 4 ft. 3 in. "Not a drop of water."

'*New Parks Service Reservoir Boring.*'—Boring made near the reservoir for the Leicester Corporation in September and October, 1896, by, and information from Messrs. C. Isler & Co., Ltd.

					Thickness	Depth
					Ft. In.	Ft. In.
Upper Keuper	{	Dry well	...	...	18 0	—
	{	Blue marl	...	...	7 0	25 0
	{	Red marl	...	...	46 0	71 0
	{	Stone	...	...	1 6	72 6
	{	Red marl	...	...	39 6	112 0
	{	Blue and red marl	...	...	10 0	122 0
	{	Red marl	...	...	4 0	126 0
	{	Stone	...	...	7 0	133 0
	{	Red marl	...	...	7 0	140 0
	{	Stone	...	...	14 0	154 0
	{	Red marl	...	...	6 0	160 0
	{	Stone	...	...	0 2	160 2

D

Lined with 50 ft. of 13½-inch tubes, top 8 ft. below surface.

Water-level 100 ft. below surface.

A small sample of the water was analysed by S. F. Burford on October 29th, 1896, and found unfit for drinking. Total hardness 81°. Practically no water in the borehole.

#### ANALYSIS

New Parks Service Reservoir Boring.

By S. F. Burford.

	Grains per gallon
Date ... ..	29.11.1896
Appearance in 2-ft. tube ... ..	Clear, bright, colourless
Smell when heated to 100° Fahr. ... ..	Nil
Chlorine ... ..	3.57
Nitrites ... ..	Faint trace
Nitrogen as nitrates, etc. ... ..	0.032
Ammonia ... ..	0.0036
Albuminoid ammonia ... ..	0.0061
Total solid matter dried at 220° Fahr. ... ..	98.0
Hardness (degrees of Clark's Scale) :—	
Temporary ... ..	8.5
Permanent ... ..	72.5
Total ... ..	81.0

#### CASTLE DONINGTON RURAL DISTRICT

This Rural District, the geology of which is shown on the 1-inch Geological Survey Map, New Series, Sheet 141, extends over principally Drift and Keuper Marl. Toward the base of the Marl is sandstone which is exposed by the road-side at Hill Top, Castle Donington, and underlies Diseworth village. At the former locality springs issue from it; at the latter wells have been sunk for the supply of the village. Just outside the southern margin of the district borings at Piper Wood, Shepshed, proved a thickness of 350 ft. of Marl.

The Marl rests on Lower Keuper Sandstone which appears at the surface in parts of the southern portion of the district, and in the northern portion at Kegworth and Castle Donington. The Piper Wood Borings proved the thickness of the Sandstone to be there about 128 ft.; the second Brickworks boring near Hathern, about 94 ft. At Castle Donington the Sandstone rests on 'Millstone Grit,' shaly layers of which throw out the 'Spital Spring' from the base of the Sandstone. Further west, Bunter Beds part the Sandstone from the 'Grit,' and they are 62 ft. thick beneath Hathern.

In a 'Report on Temporary Supply of Water for Leicester,' 13th January, 1903 (typescript), Fox-Strangways reported:

"Having given the subject some consideration it does not appear to me that the rocks are likely to contain a suitable supply of water nearer than the northern side of the Charnwood Hills. The old rocks of which these hills are composed form a ridge beneath the Keuper Marl, against the northern side of which the Lower Trias has been deposited. These Lower Triassic beds are

well known as one of the finest sources of underground water supply in the kingdom ; but, as these beds are thinning out against the barrier mentioned above, and are nearly at their south-eastern limit in this district, I do not expect that the usual abundant supply would be obtained from them here. It is probable that a fairly abundant supply would be obtained by sinking into them anywhere in the district between Kegworth and Loughborough ; the water, however, is very hard, as proved in the Brickworks borings at Hathern.

"In this district we have the record of four borings, one at Hathern which reached the conglomerate or Pebble beds at 260 ft. Water is stated to have been "most abundant," and rose 40 to 50 ft. above the surface. In another boring at Hathern Station Brickyard the Pebble beds appear to be 20 ft. thick, and were met with at a depth of 380 feet [see p. 100].

"A boring to the north of Shepshed [Piper Wood : surface 230 ft. O.D.] reached the [Lower Keuper] sandstones beneath the marl at about 350 feet, but does not appear to have met with any Pebble beds. If this is correct it would seem that the Pebble beds thin out in this direction, and therefore any boring put down in search of water should be kept to the Soar Valley. . . ."

Castle Donington and Isley Walton are supplied from the Long Eaton Urban District Council's Waterworks at Stanton-by-Bridge (from wells in Millstone Grit) ; and about half Kegworth from the same Works and about half from the Derwent Valley Water Board's Works. With these exceptions the district is dependent on private wells and a few springs, the supplies from which are said to be adequate and good.

**Breedon-on-the-Hill**—Maps : 141 ; (9 N.E., S.W., S.E., 16 N.E.)

Breedon-on-the-Hill village is dependent on wells and springs. It is situate mainly on Carboniferous Limestone, which gives rise to a prominent hill. The well at 'The Holly Bush' which is on Lower Keuper Sandstone, was recently deepened and entered the Carboniferous Limestone.

**Castle Donington** — Maps : 141 ; (4 S.E., 5 S.W., 9 N.E., S.E., 10 N.W., S.W.)

Castle Donington is on Lower Keuper Sandstone except for a small portion at the southern extremity known as Hill Top which is on the succeeding Keuper Marl in which is a bed of sandstone.

About 476 out of the 611 houses are supplied with water purchased in bulk by the Rural District Council from the Long Eaton Urban District Council. People living in the vicinity of the Gas Works obtain water from a 'spout spring' known as 'The Spital' which issues at the foot of a steep bank from the base of the Lower Keuper Sandstone that rests on Millstone Grit with shaly layers. At Hill Top springs issue by the roadside from the sandstone in the Keuper Marl : that on the east side of the road is a 'spout spring' ; that on the west side feeds a trough which is much used by horses and cattle.

*Borehole No. 6—Mr. Brigg's Land, Castle Donington.*—Site marked on 1-inch Geological Survey Map, New Series, Sheet 141, half-a-mile west of Donington Station.



G. Hodson, ' . . . Works for supplying . . . Castle Donington, . . . ' *Trans. Assoc. Mun. & Cy. Eng.*, vol. xix. 1893—repeated in ' Loughborough Memoir,' 1905, p. 52.

		Thickness		Depth	
		Ft.	In.	Ft.	In.
[Alluvium, etc.]	{ Soil and coarse gravel . . .	12	0	12	0
	{ Gravel and sand . . .	10	6	22	6
[Keuper Marl]	{ Soft red marl . . .	18	6	41	0
	{ Stronger red marl and skerry beds . . .	16	0	57	0

#### HALLATON RURAL DISTRICT

The Hallaton Rural District is on the Jurassic upland of eastern Leicestershire. This upland is composed, in ascending sequence, of Middle Lias, Upper Lias, and Northampton Beds. After these rocks had received a certain amount of furrowing by rivers, Glacial deposits were irregularly superimposed. Subsequently renewed river-furrowing has taken place, resulting in an undulating land-relief. Springs are numerous but mostly small. "Water off the blue [Upper Lias] clay smells [of sulphuretted hydrogen] in the morning when it stands in the house all night and also the first bucketful drawn from the well in the morning." (J. Gray, Surveyor to the Rural District).

**Blaston**—Maps : 156, 170 ; [64] ; (39 S.E., 46 N.E.)

The greater part of the village is on Middle Lias clays and sands ; a few houses and the church are on the Marlstone. Supplies are obtained from private wells fitted with pumps.

**Bringinghurst**—Maps : 171 ; [64] ; (47 S.W.)

The small village, which is on a knoll of Upper Lias clay capped with Glacial gravel, is dependent on private wells fitted with pumps. The supply is said to be adequate.

**Drayton**—Maps : 170, 171 ; [64] ; (46 S.E., 47 S.W.)

The small village is on Upper Lias and draws its supply from a public pump in the middle of the village.

**Great Easton**—Maps : 170, 171 ; [64] ; (46 N.E., 47 N.W., S.W.)

The village is represented on the Geological Survey Map, Old Series, Sheet 64, to be on Upper Lias, but J. Gray informs me that a considerable part is on gravel. It is dependent on wells fitted with pumps.

**Hallaton**—Maps : 156, 170 ; [64] ; (39 S.W., S.E., 46 N.W., N.E.)

The village is on Glacial gravel resting on Upper Lias clay (thin). There are three public pumps and a draw tap at the conduit.

**Horninghold**—Maps : 156, 170 ; [64] ; (39 S.E., 46 N.E.)

This village is mainly on the Marlstone, partly on the underlying Middle Lias sands and clays. It is dependent on shallow wells fitted with pumps.

**Medbourne**—Maps: 170; [64]; (46 N.E., S.W., S.E.)

The village has a piped service. Water from a spring from the base of the Northampton Beds (situate east of the railway and north of the road from Medbourne to Nevill Holt at about 550 yards N.E. from Medbourne Church) is piped to a tank by the side of the railway from which it gravitates to taps.

**Nevill Holt**—Maps: 170, 171; [64]; (46 N.E., S.E., 47 N.W.)

Nevill Holt is situate on Northampton Beds. The locality for a time enjoyed some notoriety for its Spa. The Spa building, however, which is hidden away in the larch wood that forms an eastward extension of Holt Wood, is now rapidly decaying.

*Holt Spa.*<sup>1</sup>—The medicinal water here was discovered in 1728 during an attempt made by a farmer to construct a pond to collect a seepage. Lady Migliorucci built an arch over the place where the spring was supposed to rise, took steps to protect the spring from any other water getting into it, and attempted to tap the spring further in the bank. To follow the presumed course of the water a trench was dug in the hillside to a maximum depth of 20 ft. but without success—clay only, with "great quantities of talc [? selenite]," was found. "The Spa affords only a hogshead of water in 24 hours, and sometimes less, in a great drought. . . . It rises not up like other springs, but is a mere exudation . . ." (Nichols, p. 727). Dr. Short examined the water and found its principal constituents to be:—sodium chloride, iron, and sulphuretted hydrogen. The water appears to come from a permeable band in the Upper Lias.

#### HINCKLEY RURAL DISTRICT

The geology of the Hinckley Rural District is shown on the 1-inch Geological Survey Maps, New Series, Sheets 155, 169. The district has for its 'solid' rock floor Keuper Marl except for very small areas in Stoney Stanton and Sapcote parishes where syenite protrudes through the Keuper Marl and locally the mantle of Boulder Clay. The Marl, however, is for the most part obscured by spreads of Glacial deposits consisting of Boulder Clay and associated sand and gravel. Some 261 houses out of 622 in Barwell parish; 290 out of 989 in Earl Shilton; 265 out of 357 in Stoney Stanton have Hinckley Urban District Council's water. Otherwise the houses are dependent on wells the supplies from which, though variable, are said to be on the whole adequate. It is unlikely that deep borings in search of water would be successful; the Glacial sands and gravels are the main potential sources of supply. The Sapcote Freeholt or 'Elmes-thorpe' boring put down about half-way between Sapcote and Hinckley entered Lower Keuper Sandstone at a depth of 130 ft. and proved it (1) to be 330 ft. thick, and (2) to rest on rocks probably of Cambrian age. Borings that have entered the Lower Keuper Sandstone in the Hinckley Urban District have tapped water unsuitable for a public supply on account of hardness, and high sodium chloride, etc., content.

<sup>1</sup> See Short, Dr. T., 'The Contents, Virtues, and Uses of Nevil-Holt Spaw-Water . . . 1742; 2nd ed., 1749; and 'An Essay towards a Natural, Experimental and Medicinal History of the Principal Waters of . . . Leicestershire . . . particularly those of Neville Holt . . .', 1740; also Nichols, John, 'The History and Antiquities of the County of Leicester,' vol. ii, pt. 2, 1798, pp. 726-728.

**Barwell**—Maps : 155, 169 ; (35 S.E., 36 S.W., 42 N.E., 43 N.W.)

*Barwell Spring*.—In High Close eastward of the Church (under the 'ch.' on the map) is a sand-pit in the quartzose sand of the Upper Boulder Clay group. From the sand issues a now insignificant spring which may, however, have been the origin of the place-name—Barwell. From remains found in its vicinity it is certain that the spring was resorted to from the Early Bronze Age down to mediæval times.

**Burbage**—Maps : 169 ; (42 N.E., S.E., 43 N.W., S.W.)

Burbage village is on sand and gravel (Glacial): a well at a new house on the Sketchley Road, 16 ft. deep and 10 ft. down to the water, yielded a good supply.

*Sketchley Well*.—Five-eighths of a mile south of Hinckley Railway Station. This well in sand (Glacial) is now covered and fitted with a pump, which is, however, fenced off from public use. The water had a legendary reputation for sharpening people's wits.

*Sketchley Dye Works Boring*.—330 yards S. 7°W. of railway-bridge over Rugby Road. 1915. Ht. above O.D. 327 ft.

		Thickness		Depth	
		Ft.	In.	Ft.	In.
[Boulder Clay with associated sand and gravel]	1. Top soil, sand and gravel ... ..	2	0	2	0
	2. Red clay ... ..	8	0	10	0
	3. Brown silty clay ... ..	40	0	50	0
	4. Brown silty clay intermixed with red marly clay ... ..	25	0	75	0
	5. Brown silty clay with fragments of red marl, small pebbles of quartzite, and pieces of green sandstone ... ..				
	6. Red marl with quartzite pebbles (pebbles larger towards base) ... ..				
	7. Clear red marl ... ..	21	0	96	0
	8. Red and green marls ... ..				
	9. Red marls with small quantity of gypsum ... ..				
	10. Hard red marl ... ..	14	0	110	0
	11. Red marl with a little green marl ... ..				
	12. Hard red marl ... ..				
	13. Green marl ... ..	3	0	113	0
	14. Red marl ... ..	0	6	113	6
	15. Red marl with three 2 in. bands of gypsum ... ..	6	6	120	0
	16. Red marl ... ..	2	0	122	0
	17. Mottled (red and green) marl with little gypsum ... ..	7	0	129	0
	18. Green marl ... ..	2	0	131	0
	19. Red marl ... ..	0	7	131	7
	20. Gypsum ... ..	2	0	133	7
	21. Red marl ... ..	0	1	133	8
	22. Green marl ... ..	6	0	139	8
	23. Red marl ... ..	1	6	141	2
	24. Gypsum ... ..	1	6	142	8
	25. Red marl ... ..	0	3	142	11
	26. Mottled marl with gypsum veins ... ..	1	1	144	0
	27. Red marl, calcareous ... ..	3	3	147	3
	28. Mottled marl with gypsum veins ... ..	0	8	147	11
	29. Green marl ... ..	1	6	149	5
	30. Mottled marl, chiefly red ... ..	0	4	149	9
	31. Gypsum ... ..	2	3	152	0
	32. Mottled marl, chiefly red ... ..	0	2	152	2
		4	0	156	2



		Thickness		Depth	
		Ft.	In.	Ft.	In.
[Upper Keuper]	33. Green and red marl with gypsum; con- torted bedding-lines ... ..	1	6	157	8
	34. Gypsum ... ..	0	2	157	10
	35. Green and red marl; horizontal bedding	4	9	162	7
	36. Red marl with three bands of gypsum ...	3	0	165	7
	37. Red marl ... ..	5	0	170	7
	38. Red marl with veins of gypsum ... ..	1	10	172	5
	39. Green marl ... ..	0	10	173	3
	40. Gypsum ... ..	0	1	173	4
	41. Red marl ... ..	2	9	176	1
	42. Red marl with thin veins of gypsum ...	4	0	180	1
	43. Red and green marl ... ..	0	6	180	7
	44. Gypsum ... ..	0	2	180	9
	45. Red marl ... ..	2	6	183	3
	46. Gypsum ... ..	0	1	183	4
	47. Red marl, slightly mottled ... ..	2	8	186	0
	48. Gypsum ... ..	0	3	186	3
	49. Red marl ... ..	2	8	188	11
	50. Gypsum ... ..	0	1	189	0
	51. Red marl, slightly mottled ... ..	1	3	190	3
	52. Red marl with veins of gypsum ... ..	2	0	192	3
	53. Red marl ... ..	1	9	194	0
	54. Gypsum ... ..	0	1½	194	1½
	55. Red marl ... ..	4	0	198	1½
	56. Green marl ... ..	0	6½	198	8
	57. Red marl with a little gypsum ... ..	2	6	201	2
	58. Green marl ... ..	0	7	201	9
	59. Red marl with veins of gypsum ... ..	2	5	204	2
	60. Red marl ... ..	3	0	207	2
	61. Gypsum ... ..	0	1	207	3
	62. Red marl ... ..	4	0	211	3
	63. Gypsum ... ..	0	1	211	4
	64. Green marl ... ..	0	4	211	8
	65. Red marl ... ..	1	6	213	2

Made by Chas. J. Ell, Luton, Beds. Bored to 113 ft. with jumping chisel; to 213 ft. 2 in. with shot-drill and cores of 7½ in. in diameter drawn. Boring abandoned as supply was found to be insufficient.

The above record was published by A. J. Pickering.<sup>1</sup>

### Higham-on-the-Hill—Maps: 155, 169; (35 S.W., 42 N.W.)

*Lindley Hall Borings.*—Trial borings for coal. The deepest boring, 660½ ft., was near Fenn Lanes. Two other borings (222 ft. and 333½ ft.) were made near by: one (333½ ft.) in a field called Barn Close between Chads Lane and Watling Street. Details of the deepest boring, noted by the Rev. W. H. Coleman, are given in the 'Atherstone Memoir,' pp. 66-69. Fox-Strangways says: "Here the base of the Trias is supposed to have been reached at 660 ft." (*loc. cit.*, p. 41). See also 'Coventry Memoir,' p. 94; [Sir] A. Strahan, *Geol. Mag.*, 1886, p. 555.

Summarized section:—

Summarized section :—					Thickness	Depth
					Ft.	Ft.
Drift	Soil, red clay, etc.	...	...	...	7	7
Keuper	{	Red marl with red and blue rock and			453	460
Marl		gypsum	...	...		
Lower Keuper	{	Blue, red, and brown rock with marl	...		200½	660½
Sandstone						
?Coal Measures.						

<sup>1</sup> On Two Borings for water at Hinckley, Leicestershire. *Geol. Mag.*, 1916, pp. 70-73.

**Sapcote**—Maps : 169 ; (43 N.W., N.E., S.W., S.E.)

Sapcote village is on Boulder Clay in which, however, are irregular veins and lenticles of gravel. Masses of syenite, which are actively quarried, protrude through the mantle of Boulder Clay, etc.

A few cottages are supplied by the Enderby and Stoney Stanton Granite Co., Ltd., but otherwise the parish is dependent on wells.

*Sapcote Freeholt (or Elmes Thorpe) Boring.*—Site marked on map halfway between Hinckley and the syenite boss of Sapcote. Ht. above O.D. ? 350 ft. Sir Andrew Ramsay, *Rep. Coal Commission*, 1871, vol. ii, p. 134 ; J. Plant, *Rep. Brit. Assoc.* for 1875 (1876), p. 137 ; C. E. de Rance, *Trans. Manchester Geol. Soc.*, vol. xv, 1878, p. 95 ; W. J. Harrison, *Mid. Nat.*, vol. viii, 1885, p. 163 ; [Sir] A. Strahan, *Geol. Mag.*, 1886, p. 556 ; H. T. Brown, *Quart. Journ. Geol. Soc.*, vol. xlv, 1889, pp. 29, 30 ; 'Coventry Memoir,' 1923, p. 96.

T. Eastwood says ('Coventry Memoir,' p. 96 footnote) : "Of this boring several discordant accounts have been published. In one 980 ft. of beds are assigned to the Coal Measures ; in another only 210 ft. 5 in. In a third no Coal Measures whatever are admitted. The view adopted in the text [that Coal Measures are absent] is the safest, but in the absence of samples the question must remain unsettled." The interpretation adopted (p. 128) is that of Sir Aubrey Strahan and is :—

	Thickness	Depth
	Ft.	Ft.
Boulder Clay...	10	10
Keuper Marl ...	120	130
Lower Keuper Sandstone ...	330	460
? Cambrian. Slaty rocks with a dip of 70° ...	1195	1655
Water-level (rest), ? 800 ft. down.		

H. T. Brown<sup>1</sup> states : "Through the kindness of Mr. J. A. Bosworth, of Leicester, under whose superintendence the boring was made, I have been able to examine his very carefully prepared section, and also to see some of the cores. The following are the details, which, it will be seen, differ materially from those given above [by Strahan] :—

*Boring at Sapcote Freeholt*

		Ft.	In.
Upper Keuper	Alternating grey and red marls, in part very gypseous ...	470	0
	A very hard bed of conglomerate or breccia ; fragments for the most part consisting of small pieces of quartz ...	A few inches	
	Purple marl ...	20	0
Coal-measures	Dark-coloured shales, containing at 40 ft. from top a seam of coal about 4 ins. thick	40	0
	'Bat,' i.e., carbonaceous clay ...	0	5
	Grey and reddish sandstones, which Mr. Bosworth certainly refers to Coal-measures ...	150	0
Upper Cambrian	Indurated bluish (Stockingford) shales ...	974	0
		1654	5

"There are certainly no beds in the above section which can be referred to the Lower Keuper (Waterstones) ; the grey and red gypseous marls belong to the Upper Keuper, and have at their base a thin band of fine breccia which closely resembles a rock found in the neighbourhood of Whitwick, where the Keuper rests on the Forest rocks. It is possible that the 20 feet of purple

<sup>1</sup> *Quart. Journ. Geol. Soc.*, vol. xlv, 1889, pp. 29, 30.

marls may be of Permian age, but it is more probable that they form part of the underlying shales which have been stained by percolation from above. In the 190 feet of beds below the purple marl we have unmistakable Coal-measures, containing a thin seam of coal; and these rest upon dark-coloured bluish shales, undoubtedly belonging to the Stockingford Series."

*Golden Well.*—At Bath House, Bath Street, Sapcote (on the east side of the street immediately west of the 'S' of 'Smithy' on the 1-inch Geological Survey Map) is a well deriving its supply from sand and gravel associated with the Boulder Clay that has been known from time immemorial as 'Golden Well.'<sup>1</sup> The water is slightly chalybeate; in the past was held in high repute as being "particularly serviceable in nervous, consumptive, scorbutic and scrophulous complaints; and many that have been afflicted with weak and sore eyes have found considerable relief, and some a perfect cure"; and is still regarded as "good for rheumatism."

In 1806 John Frewen Turner erected a bath house in which hot or cold baths could be had. According to the present (August, 1927) occupier the well is still in existence (fitted with a pump), but the bath house is now used as a stable in which "there are some white tiles where the hot baths used to be."

*Soap (or Sope) Well.*—The site of this well has been forgotten. The Rev. Henry Whiteley<sup>2</sup> wrote in his 'History of the Parish of Sapcote . . .' (p. 10):—"There is, a little way out of the village, a well, which was formerly far-famed, called Soap-well, of remarkably soft water. Tradition said that the water would wash without soap, and hence the name of the well. It is now disused. . . ."

### **Stoney Stanton**—Maps: 169; (43 N.W., N.E.)

According to Dr. S. W. Wheaton<sup>3</sup> "The water supply of Stoney Stanton is derived from water accumulating in, and pumped from, one of the quarries of the Mount Sorrel 'Granite' Company. The water is pumped into a filter, through which it passes into a tank, from which it is distributed in pipes by gravitation. This supply has only been introduced since 1893, and many of the houses in the more outlying parts of the village are still supplied from wells. . . ."

## **LUTTERWORTH RURAL DISTRICT**

The smaller western portion of this district, in which are situate Bittersby, Claybrooke Magna, Claybrooke Parva, Frolesworth, Leire, and Ullesthorpe, has for its 'solid' rock Keuper Marl; the greater eastern portion, Lower Lias. These 'solid' rocks, and, from the present standpoint, the intervening unimportant Rhaetic, are, for the most part obscured by extensive Glacial deposits consisting of Boulder Clay with associated gravel and sand.

Except for Lutterworth there are not any public piped supplies in the district. The majority of the larger villages are situate on Glacial gravel and sand and derive their supplies from shallow wells sunk therein.

<sup>1</sup> Nichols, John, 'The History and Antiquities of the County of Leicester,' vol. iv, pt. 2 (1811), p. 897.

<sup>2</sup> White, Wm., 'History . . . of Leicester and Rutland, . . .,' 2nd ed., 1863, p. 706; Whiteley, Rev. Henry, 'History of the Parish of Sapcote . . .,' 1853, p. 13, *Leicester*.

<sup>3</sup> 'Report on an outbreak of Diphtheria in the Hinckley Urban and Rural Sanitary Districts.' 23rd Ann. Rep. L.G.B., 1893-94 (1894), pp. 143-164.



It is unlikely that deep borings in search of water would be successful: the Glacial gravels and sands—from which a number of useful springs issue—are the only potential sources of supply. The water, however, is on the hard side and locally chalybeate.

**Bitteswell**—Maps: 169, 170; [63 S.E.]; (48 N.E., S.E., 49 N.W.)

This village is mainly on Boulder Clay overlying Glacial sand. It is dependent on wells the water in many of which is said to be polluted.<sup>1</sup> The Commissioners appointed to inquire into the best means of preventing the pollution of rivers had analyses made of waters drawn from six of the wells and found only one sample "not actually dangerous to use for domestic purposes."<sup>2</sup>

#### ANALYSIS

*Bitteswell Hall*, water from tap in stable yard. By J. T. Thomas, D.P.H.

						Grains per gallon
Date	...	...	...	...	...	3.6.1898
Appearance in 2-ft. tube	...	...	...	...	Clear, bright, yellowish	
Smell when heated to 100° Fahr.	...	...	...	...	None	
Chlorine	...	...	...	...	2.15	
Nitrites	...	...	...	...	None	
Nitrates as nitrogen	...	...	...	...	0.65	
Ammonia, free	...	...	...	...	0.0014	
Ammonia, albuminoid	...	...	...	...	0.0042	
Oxygen absorbed by organic matter in 15 mins. at 80° Fahr.	...	...	...	...	0.0133	
Metals	...	...	...	...	iron (trace)	
Total solid matter	...	...	...	...	41.0	
Hardness (degrees of Clark's Scale)	...	...	...	...	23.0	

*Remarks.*—This water is well within the limits of a potable water, but gives indication of some pollution with organic matter; this, however, at present is fairly well oxidised.

*Garner's Spring.*—Half-a-mile north-west of the Manor House, on land belonging to T. Garner, a spring from Glacial sand and gravel yielded—according to W. Keay—in January, 1923, 12,000 gallons per day.

**Broughton Astley**—Maps: 169, 170; [63 S.E.]; (43 N.E., S.E.)

*Well to cottages near Railway Station.*—Information from W. Keay. Sunk March, 1911.

		Thickness	Depth
		Ft.	Ft.
[Boulder Clay with associated sand and gravel]	Hard tough blue clay, not many stones, no chalk	44	44
	Fine reddish-brown sand	4	48
	Hard tough blue clay	0½	48½
	Fine reddish-brown sand	11½	60

\* About 1 ft. 10 in. of water in well.

<sup>1</sup> 'Return as to Water Undertakings in England and Wales,' *Local Government Board*, 1915, p. 455.

<sup>2</sup> Sixth Report, Rivers Pollution Commission, 1874, p. 318; also p. 79.

*Note.*—January 30, 1912.—The supply to this well appeared to be sufficient, but the quality is questionable. Occasionally the water was dark in colour and had a very disagreeable smell. There has been no smell for the past two months and the water is clear but not good.

*Primethorpe*, well at; three-quarters of a mile east of Soar Mill. Sunk (1918) by J. Cook, Broughton Astley, and communicated by him per W. Keay. Ht. above O.D., about 300 ft.

		Thickness	Depth
		Ft.	Ft.
[Boulder Clay and associated sand and gravel]	Red clay: about ... ..	20	20
	Sand, reddish and dry until water was reached at the bottom ...	50	70

The dryness of the Glacial sand was particularly noticeable. The water was clear and of good quality.

**Bruntingthorpe**—Maps: 170; [63 S.E.]; (44 S.E., 49 N.E.)

This village is mainly on the gravel which is associated with the Boulder Clay.

*Musson's Row.*—Well, 11 ft. deep in Lower Lias clay, water-level 3 ft. down; supply good. Information from J. A. L. Beasley.

*Housing Estate.*—Well, 80 ft. deep in Lower Lias clay; no supply. Information from A. J. Ross (April, 1927).

**Catthorpe**—Maps: 170; [53 N.E.]; (52 S.E., 53 S.W.)

*Catthorpe Towers.*—A boring was made here to a depth of 200 ft. in Lower Lias, but—as might be expected—yielded no supply. Water is now obtained from a spring from Glacial gravel at Stanford-on-Avon.

**Dunton Bassett**—Maps: 169, 170; [63 S.E.]; (43 S.E., 44 S.W., 48 N.E., 49 N.W.)

*Boggy Breas (or Brays or Brayes).*—This is an area some two and a half miles north of Leicester on the west side of the Leicester Road. W. Keay says (in a Report dated March 22nd, 1923): "*Near Slip Inn Farm.*—In July last the springs issuing from Glacial gravels on the east and west side of the valley yielded 85,000 gallons per day.

"I have on two further occasions gauged the springs, confining attention to those on the east side of the stream on land belonging to Major Aikman and Mr. E. W. Lavender with results as follows:—

				1922 (Dec. 15th)	1923 (March 12th)
				(a dry period)	
				Gallons per day	Gallons per day
Spring No. 1	...	...	...	4,320	5,280
" 2	...	...	...	7,800	11,420
" 3	...	...	...	5,370	6,530
" 4	...	...	...	3,530	6,700
" 5	...	...	...	15,530	21,070
" 6	...	...	...	12,650	17,160
Other small springs	...	...	...	5,000	6,000
				<hr/> 54,200	<hr/> 74,160

"The measurements of the springs in December, 1922, were recorded after a comparatively dry period, the rainfall for the preceding three months being only 4.14 inches. . . . I have found that the rest level of the present well [Lutterworth Waterworks] is lowest in December."

The following are the remarks by the Analyst :—

*Spring No. 1.*—Both the chemical and bacteriological results indicate a water of very good quality. It has a rather high temporary hardness.

*Spring No. 3.*—This sample has decided traces of unoxidised organic matter present and it is rather surprising to find it so free from organisms, especially as animals are in such close proximity to the source. The water may be regarded in its present condition as quite safe for drinking purposes.

*Spring No. 6.*—Both the chemical and bacteriological results are highly satisfactory, and the water may be regarded as of a high degree of organic and bacterial purity.

Hardness :—

		Lutterworth Works	Spring No. 1	Spring No. 3	Spring No. 6
Temporary	...	15·0	18·6	19·8	16·6
Permanent	...	8·0	3·3	2·8	7·2
Total	...	<u>23·0</u>	<u>21·9</u>	<u>22·6</u>	<u>23·8</u>

**Frolesworth**—Maps : 169 ; (43 S.W., S.E., 48 N.W., N.E.)

With the exception of the extreme western end, which is on Boulder Clay, this village is on Glacial sand and gravel.

*Near centre of Frolesworth village.*<sup>1</sup>—"Three bores were put down in Boulder Clay in the orchard. . . . The depth of these three bores varied from 50 to 60 feet, but the exploitation was given up as a failure. Sand [Glacial] and water were known to exist on the opposite side of the house, but it was feared that the water was polluted."

*Ivy Cottage,*<sup>1</sup> *Frolesworth village.*—Well (by back door) in "sandy loam with running sand [Glacial]," 16 feet deep, water-level 13 feet down ; supply fair but polluted.

*Ball's Farm,*<sup>1</sup> *Frolesworth village.*—Well (in orchard) in "loam and sand with black veins to running sand [Glacial]," 20 feet deep, water-level 17 feet down ; supply fair.

*White House,*<sup>1</sup> *Frolesworth village.*—(1) Well (in yard), 25 feet deep, in "loam and sand with black veins of sand [Glacial]," water-level 19 feet down ; supply good. (2) Well (in garden), 16 feet deep, in loam and sand [Glacial], water-level 12 feet down ; supply good.

**Gilmorton**—Maps : 170 ; [63 S.E.] ; (49 N.W., S.W.)

On December 18th, 1922, W. Keay gauged a spring issuing from Glacial sand and gravel on land belonging to Mrs. H. Bloxham lying between Gilmorton and Peatling Parva about one mile east-north-eastward of Gilmorton Church. This spring works a ram that supplies Gilmorton Mill House and Farm about 400 acres in extent, and yielded on the date mentioned 28,000 gallons per day. The height of the spring above O.D. is 436 ft.

**Kimcote and Walton**—Maps : 170 ; [63 S.E.] ; (49 N.W., N.E., S.W., S.E.)

*Kimcote*, well at. Communicated by W. E. Grewcock, A.R.I.B.A. October, 1913. Ht. above O.D., 433·8 ft.

<sup>1</sup> Information from J. A. L. Beasley.



		Thickness Ft.	Depth Ft.
[Boulder Clay and associated gravel]	{ Gravel; no water ... .. }	21½	21½
	{ Boulder Clay ... .. }		
	{ Limestone [probably a boulder of Liassic limestone.—W. Keay] ... .. }	0¾	22
	{ [? Boulder Clay] ... .. }	3	25
[? Lower Lias]	Dark blue clay.		

Yield.—Said to have made 1,000 gallons in 4 hours.

**Lutterworth**—Maps: 169, 170; [63 S.E.]; (48 S.E., 49 N.W., S.W., 52 N.E.)

*Lutterworth Waterworks* (Lutterworth Rural District Council).

*Old Supply*.—Bitteswell Road. Well: height above O.D., 414.18 ft. 8-inch tube put down in February, 1901, and information from (per W. Keay) Messrs. C. Isler & Co., Ltd.

		Thickness Ft.	Depth Ft.
Glacial Deposits	Dug well (diameter, 6 ft.) :—		
	1. Gravel ... ..	36½	36½
	Borehole (diameter, 8 in.) :—		
	2. Ballast ... ..	4½	41
	3. Blue clay ... ..	1	42
	4. Clay stone ... ..	0½	42½
Lower Lias	5. Fine ballast ... ..	1½	44
	6. Hard blue clay ... ..	2½	46½

The well was deepened by A. E. Palmer, Contractor, in June, 1909, thus making a total depth of 46½ ft. The tube was taken out and a brick floor put in the bottom. The well walls are 9 in. thick in cement with open spaces in each course. An opening for a future heading is left 4 ft. 6 in. by 2 ft. 9 in. wide filled with brickwork and a straight joint.

The greater quantity of water enters the well near the bottom. The maximum yield (January, 1927) was about 29,400 gallons a day, but this quantity can only be obtained by keeping the well empty and by running the pumps continually at a slow speed, for the water rises in the well at the rate of 1 ft. 9 in. during the first quarter of an hour and if pumping be discontinued the rate of rise decreases. The water is pumped to a tank, in a water tower, of about 32,000 gallons capacity.

*Trial Boring*.—Made through bottom of gravel pit at 100 ft. from well in October, 1923, to see if more water could be obtained. Made by Messrs. C. Isler & Co., Ltd. Ht. above O.D., about 394 ft.

		Thickness Ft.	Depth Ft.
[Glacial]	Borehole (diameter, 6 in.) :—		
	{ Made ground ... .. }	5	5
	{ Clay and ballast ... .. }	9	14
	{ Ballast ... .. }	6	20
[Lower Lias]	{ Clay and stones ... .. }	2	22
	{ Clay ... .. }	18	40
	{ Clay and small stones ... .. }	13	53

Cased with 31½ ft. of 2-inch tubes.

Result.—No water found.

Messrs. Pick, Everard, and Keay stated (*in litt.*, 1st November, 1923): "We were rather surprised not to find any water in the boring at the time we took our measurements. We found, however, from past experience of the well that the saturation level from October to February is usually at its lowest.

The water is evidently finding its way along the top of the clay at the base of the gravel to the well and the pumping [at the Waterworks] throughout the day does not allow the saturation level to rise."

**2. New Supply.**—Works are in progress for the purpose of augmenting the present supply of water to Lutterworth from springs from Glacial sand and gravel resting on Lower Lias in the vicinity of Rye Close Spinney, in the parish of Misterton, owned by the Leicestershire County Council. The water will gravitate to a Pumping Station on the east side of the Rugby Road, about fifty yards from the existing water-mains, into which it will be pumped to the present water-tower. The average daily quantity of water that will be available will be about 70,000 gallons.

**Springs on Lutterworth Golf Course.**—About a mile to the south of Lutterworth near Cotesbach, five springs issue from Glacial sand and gravel at various points on land belonging to Mrs. Marryat and Mr. Hurd. The total yield of the springs, according to W. Keay, who gauged them in January, 1923, was 26,000 gallons a day. The water is used for general farm purposes. The level of the springs is about 380 ft. O.D.

**Spring at Ryehill Farm.**—Numerous small springs issue on land belonging to George Cockerill to the east of the Railway Station and have—according to W. Keay—a total delivery from the twelve springs of 20,000 gallons per day at a level of about 380 ft. O.D.

**Moor Barns Springs.**—These springs are situate a quarter-of-a-mile south of Wood-bridge Hill (Map 169) and issue from Glacial sand and gravel in the Boulder Clay. They yield about 32,000 gallons per day.

#### ANALYSIS

Public Supply. Sample taken direct from well 10.6.1910.

Analysis by Dr. J. C. Thresh.

Turbidity: Clear, a few particles of sand were present in the sample.

Colour: Greyish yellow. Odour: None. Reaction: Neutral.

#### Results expressed in parts per 100,000

Ca	Mg.	Na.	CO <sub>3</sub>	SO <sub>4</sub>	Cl.	NO <sub>3</sub>	Probable combinations	
14.8	0.6	1.4	16.6	9.6	2.2	2.5		
11.0			16.6				Calcium Carbonate	27.6
3.8				9.1			Calcium Sulphate	12.9
	0.13			0.5			Magnesium Sulphate	0.63
	0.47				1.36		Magnesium Chloride	1.83
		0.5			0.84		Sodium Chloride	1.34
	0.9				2.5		Sodium Nitrate	3.4
							Etc.	0.30
Total solid constituents dried at 180° C.							...	48.0
Hardness: Temporary, 20°, Permanent, 11°. Total							...	31°
Free Ammonia							...	0.001
Organic Ammonia							...	0.006
Oxygen absorbed in 3 hours at 37° C.							...	0.020
Nitrites							...	Nil

The water contains a rather large amount of lime salts and a very small quantity of magnesia salts. The chlorides and nitrates are not excessive for a gravel water. The organic matter present is small in amount and the analysis affords no indications of pollution.

**Misterton**—Maps: 170; [63 S.E.]; (49 S.W., S.E., 53 N.W.)

'*Burton's Springs.*'—Five springs issue from Glacial gravel and sand on Mr. Burton's ground situate between the railway and Misterton Church. From gaugings at intervals during five weeks (in December, 1926, and January, 1927) E. H. Crump ascertained the yield was 50,000 gallons a day. Below analyses are given of (1) springs in Burton's ground; and (2) Misterton Hall ram spring.

*Rye Close and Winterfield Springs.*—North-eastward of Middle Farm two springs issue from Glacial gravel near Rye Close Spinney and one near Winterfield Spinney. They have been gauged by Mr. Crump in like manner to 'Burton's Springs' and showed a total daily yield of 71,000 gallons.

*Raspberry Spinney Springs.*—On the south side of the River Swift, immediately east of Middle Farm, small springs burst out near Raspberry Spinney, but the water is chalybeate.

*Thornborough Spinney Springs.*—This spinney is close to the east side of the brook west of Obbrook Farm. A number of useful springs issue from the gravel near the spinney.

#### ANALYSES

Springs from Glacial gravels: (1) In Burton's field; (2) Misterton Hall ram; and (3) east of Misterton Hall. By S. F. Burford.

Quantities expressed in parts per 100,000

Date	...	...	...	...	1	2	3
Appearance in 2-ft. tube	...	...	...	...	21.1.24 Clear: very pale straw tint.	21.1.24 Clear: almost colourless	21.1.24 Turbid: pale straw tint.
Odour	...	...	...	...	None	None	None
Reaction	...	...	...	...	Very slightly alkaline.	Very faintly alkaline.	Very faintly alkaline.
Metals	...	...	...	...	None	None	None
Chlorine	...	...	...	...	1.74	2.0	1.55
Nitrites	...	...	...	...	None	None	None
Nitrogen as nitrates, etc.	...	...	...	...	0.36	0.46	None
Ammonia	...	...	...	...	0.003	0.0010	0.004
Albuminoid ammonia	...	...	...	...	0.0196	0.0159	0.0315
Oxygen absorbed from permanganate in 15 min. at 80° Fahr.	...	...	...	...	0.0421	0.0842	0.0640
Total solids, dried at 220° Fahr.	...	...	...	...	53	52	49
Hardness (degrees of Clark's Scale)	...	...	...	...	18	20	21.5
Microscopical examination of deposit	...	...	...	...	Satisfactory	Slight earthy debris	Satisfactory

*Remarks:* 1.—Suitable for drinking and general use. It is somewhat hard but is rendered softer by boiling.

2.—This is water of good quality and may be used for drinking and general purposes. It is somewhat hard.

3.—This water though somewhat peaty is free from sewage pollution. The water may be used for drinking.

**Peatling Parva**—Maps: 170; [63 S.E.]; (44 S.W., S.E., 49 N.W., N.E.)

*Well 300 yards S.S.W. of St. Andrew's Church.*—Information from W. Keay. 1920. Ht. above O.D., about 440 ft.



					Thickness	Depth
					Ft.	Ft.
Glacial	{	Sandy soil ... ..	...	...	5	5
		Fine clean gravel and sand ...	...	...	15	20
		Loamy sand (yellow) ... ..	...	...	10	30
? Lower Lias		Blue clay ... ..	...	...	10	40

No water.

*Rectory Well*.—Information from W. Keay. Ht. above O.D., 460 ft.  
80 ft. deep: plenty of water.

*S.S.W. of Rectory, well*.—Information from W. Keay. 1920. Ht. above O.D., about 440 ft. Position fixed by Mr. Potter's (builder) son, an amateur water diviner.

					Thickness	Depth
					Ft.	Ft.
Glacial	{	Sandy soil ... ..	...	...	5	5
		Clean gravel ... ..	...	...	15	20
		Sand ... ..	...	...	10	30
		Blue clay (free from fragments of chalk)	...	...	8	38
		Chalky clay (blue) ... ..	...	...	2	40

No water and abandoned.

A second well was sunk near this well at a spot fixed by Mr. Swain, water diviner, of Croft, and at about 40 ft. was abandoned. Deposits similar.

*Well*.—Near the preceding two that were abandoned. Information from C. F. Ryan per W. Keay. 1920. Ht. above O.D., about 440 ft.

					Thickness	Depth
					Ft.	Ft.
[Glacial]	{	Sand and gravel ... ..	...	...	34½	34½
		Blue clay ... ..	...	...	5	39½
		Blue clay with fragments of chalk in the top 10½ ft., which were smaller toward the bottom, while at the bottom the clay was devoid of chalk fragments ...			32½	72

At 72 ft. water burst in (? from underlying Glacial sand), and as there was no time—owing to the inrush of water—to brick the bottom 6 ft., the well was filled in to this depth with gravel to support the brickwork. 36 ft. from surface to water.

### Shearsby—Maps: 170; [63 S.E.]; (44 S.E.)

*Shearsby Spa*.—Shearsby Spa is situate in a hollow in Lower Lias clay country. It is not uncommon to meet with ponds in the Lower Lias clay the water in which is saline—the saline constituents being derived from the Lower Lias.

John Nichols stated<sup>1</sup>: "In this lordship is a famous salt spring, situate not a hundred yards from the public road from Shearsby to Bruntingthorpe, about half-a-mile from Shearsby. It is an uncovered round pit at which no cattle will drink. It is about ten or twelve yards in circumference, and in August, 1805, was about a yard and a half deep, being then full. Its taste is very saline and brackish, without any acidity; and in very dry seasons is probably more salt than it was after the last wet summer. The son of an inhabitant of Shearsby some time since drank the water, and bathed in it for a scorbutic complaint, and found great benefit from it: . . . The land in which this

<sup>1</sup> 'The History and Antiquities of the County of Leicester,' vol. iv, pt. 1, 2nd ed., 1810, pp. 333, 334.

spring is, is now the property of a Mr. Reeve of this place, who has some thought of erecting a building over the spring."

J. D. Paul remarked in 1887<sup>1</sup>: "Since then [when Nichols visited the place] the pond has been filled up, the site laid out as a garden, a well has been sunk, suitable baths constructed, and very comfortable accommodation provided for bathers."

Paul was of opinion that the 'spring' rose from the Keuper beds—deriving its mineral constituents therefrom—through some fault or crevice in the Lower Lias. This opinion is however, erroneous: the mineral constituents come from the Lower Lias.

In the British Association 'Guide to Leicester and District,' 1907, it is stated (pp. 128, 129): "The waters have similar properties to those at Harrogate and are efficacious in cutaneous diseases, indigestion, rheumatism, bilious and nervous disorders. There are two baths, and visitors can be accommodated in the Bath Hotel. . . ."

At the present time (1927) the mineral water is pumped from the well for drinking or for bathing purposes, and one bath is in use for the latter purpose at the Bath Hotel.

## ANALYSIS

*Shearsby Saline Water.* From the Lower Lias.

					Grains per gallon
Carbonate of iron	...	...	...	...	traces
Carbonate of lime	...	...	...	...	9·743
Carbonate of magnesia	...	...	...	...	6·246
Carbonate of soda	...	...	...	...	5·581
Sulphate of soda	...	...	...	...	128·989
Chloride of sodium	...	...	...	...	245·532
Chloride of potassium	...	...	...	...	traces
Hydrosulphide of sodium	...	...	...	...	0·275
Iodine and bromine combined	...	...	...	...	traces

Specific gravity, 100·469

Made some years previous to 1886 by R. Hayton Davis.<sup>2</sup>

**Ullesthorpe**—Maps: 169; (48 N.W., N.E., S.E.)

Well in Boulder Clay and associated sand at house in Ashby Lane adjoining sale-ground. Information from W. E. Grewcock, A.R.I.B.A.<sup>3</sup> 1901-02. Map, Warwick 18 N.E. Ht. above O.D., 397 ft.

					Thickness	Depth
					Ft.	Ft.
[Boulder Clay and associated sand]	Drift clay	...	...	...	43	43
	Sand	...	...	...	10	53
	Grey marl	...	...	...	15	68
	Drift clay	...	...	...	55	123
	Sandy loam	...	...	...	13	136
	Red sand	...	...	...	8	144

<sup>1</sup> 'Shearsby—The Cheltenham of Leicestershire,' *Trans. Leicester Lit. and Phil. Soc.*, vol. i, pt. 3, 1887, pp. 10, 11.

<sup>2</sup> Published by J. D. Paul in 'Shearsby—The Cheltenham of Leicestershire,' *Trans. Leicester Lit. and Phil. Soc.*, vol. i, pt. 3, 1887, p. 10; repeated in 'A Guide to Leicester and District,' *Brit. Assoc.*, 1907, pp. 128, 129.

<sup>3</sup> Noted in the 'Coventry Memoir,' p. 130.

*Well 300 yards N.E. of Railway Station.*—Information from W. Keay.

				Thickness		Depth	
				Ft.	In.	Ft.	In.
Well (sunk in 1907) :—							
[Boulder Clay and associated sand]	Boulder Clay	...	...	43	6	43	6
	Sand	...	...	10	0	53	6
	Grey clay	...	...	70	0	123	6
	Sandy loam	...	...	13	0	136	6
	Clay...	...	...	8	0	144	6
	Boring (4 in. diameter) :—						
	Blue-grey clay	...	...	8	0	152	6
	Dark clay	...	...	8	0	160	6
	Gritty band	...	...	0	1	160	7
	Red clay	...	...	8	6	169	1
	Grey sand	...	...	3	0	172	1

*Goodacre's Well.*—Trial well sunk in Mr. Goodacre's field 800 ft. north of Ullesthorpe Brickworks. Information from W. Keay. Ht. above O.D., about 350 ft.

				Thickness		Depth	
				Ft.		Ft.	
Soil				1		1	
Peaty earth				1		2	
Glacial	Gravel and sand			3		5	
Lower Lias	Dark blue clay			2		8	

With two collecting drains. Yield of well alone: 500 gallons a day. Yield of well and drains, rises 1 ft. in 16 minutes=4,500 gallons a day. Well was tested by pumping from October 24th-27th, 1908. The months of September and October were exceptionally dry. The westerly drain (41 ft., 3 in. diameter) was laid at the junction of the gravel and Lias clay; the easterly drain (32 ft. by 3in.) all in gravel, the clay being about 2 ft. lower at the top end.

#### ANALYSES

1.—Spring (2,500 gallons per day) from Glacial sand at Four Elms Lodge (near ram); 2.—Spring (10,800 gallons per day) from Glacial sand near brickyards. By S. F. Burford.

				Grains per gallon	
				1	2
Date	...	...	...	11.3.07	11.3.07
Appearance in 2-ft. tube...	...	...	...	Clear, colourless	Slightly turbid
Odour when heated to 100° Fahr.	...	...	...	None	None
Chlorine	...	...	...	1.35	1.14
Nitrites	...	...	...	None	None
Nitrogen as nitrates, etc.	...	...	...	0.12	0.04
Ammonia	...	...	...	0.0007	None
Albuminoid ammonia	...	...	...	0.0135	0.0012
Oxygen absorbed by organic matter in 15 min. at 80° Fahr.	...	...	...	0.0267	0.0140
Total solid matter dried at 220° Fahr.	...	...	...	32.2	26.6
Hardness (degrees of Clark's Scale) :—					
Permanent	...	...	...	14.5	13.5
Temporary	...	...	...	12.5	8.5
Total	...	...	...	27.0	22.0
Microscopical examination of deposit				Slight earthy	Sandy only

*Remarks* :—1 and 2.—Organically pure, moderately hard, and well adapted for drinking and domestic purposes.



**Willoughby Waterless**—Maps : 170 ; [63 S.E.] ; (44 N.W., S.W.)

*George Elliott Inn.*—Well (15 feet) and boring (51 feet) striking a “water store” about 6 in. thick [Lower Lias limestone] at 65½ feet. “A good supply was reached and rose to within 16 feet of the surface of the yard.” Information from J. A. L. Beasley, Leicester.

## MARKET BOSWORTH RURAL DISTRICT

The geology of this district is shown mainly on the Geological Survey Map, New Series, Sheet 155 ; in part on the Sheet to the south—169. Keuper Marl is the ‘solid’ rock that floors the district except in the parishes of (1) Ibstock, in which Lower Keuper Sandstone occurs at the surface ; and (2) Groby, Markfield, Ratby, and Stanton-under-Bardon in which masses of syenite and/or Charnian (Pre-Cambrian) rocks project through the Marl. The surface of the Marl, however, is extensively obscured by Glacial deposits—Boulder Clay with under- and/or over-lying sand and gravel ; while gravel (river-terrace) borders locally the lower reaches of the River Sence and Sence Brook.

The tracts where the Boulder Clay occurs at the surface are scantily populated. Nearly all the villages are located on the Glacial sand and gravel which provided a dry site and water readily obtainable by means of shallow wells. Such villages are : Bagworth, Barlestone, Barton-in-the-Beans, Bilstone (part), Cadeby, Carlton (part), Congerstone, Dadlington, Desford, Gopsall, Groby (part), Ibstock (part), Kirkby Mallory, Market Bosworth, Nailstone, Newbold Verdon, Osbaston (mainly), Shackerstone (mainly), Stapleton (mainly), and Twycross. Villages on the Keuper Marl are : Allerton, Bilstone (mainly), Fenny Drayton, Groby (part), Markfield (part), Norton-juxta-Twycross, Orton-on-the-Hill (on sandstone in the lower part of the Keuper Marl), Peckleton, Ratby (part), Ratcliffe Culey, Sheepy Parva, Sibson, and Upton. Ibstock is in part on Lower Keuper Sandstone ; Markfield mainly on syenite.

Some 198 houses in Groby parish (155 in Groby village), and 67 in Ratby parish have Leicester Corporation water ; and 16 out of 168 in Market Bosworth parish Hinckley water. About 50 out of 139 houses in Thornton parish are supplied by an undertaking belonging to the Warwick Estates Co., Ltd. Otherwise the district is dependent on wells, the supplies from which are said to be satisfactory as regards quantity and quality.

H. G. Davey, Surveyor and Inspector to the Rural District Council, informs me that—apart from those noticed in the following pages—he does not know of any springs in the district worth mentioning.

**Bagworth**—Maps : 155 ; (23 S.E., 24 S.W., 29 N.E., 30 N.W.)

*Bagworth Colliery* :—

1.—Ht. above O.D., 533 ft. The section from White’s History of Leicestershire, 1862, p. 107, with additions from Rev. W. Coleman’s MSS., is given in

the 'Coalfield Memoir,' pp. 303-304; and, with slight differences in the Vertical Sections of the Geological Survey, Sheet 19, No. 1.

Summarized section :—

		Thickness		Depth	
		Ft.	In.	Ft.	In.
[Keuper]	Red marl with occasional skerries and layers of sandstone...	203	0	203	0
	Sandstone ... ..	20	6	223	6
	Red marl with a sandstone bed in the upper part ... ..	88	6	312	0
	Stone ... ..	4	0	316	0
[Coal Measures]	Bind ... ..	9	0	325	0
	Coal ... ..	1	4	326	4
	Measures with seams of coal ...	624	4½	950	8½

Approximate quantity of water pumped daily, practically all from the Keuper, 270,000 gallons. Hardness, 70° (W. Keay).

2.—New Sinking, 1885. From E. D. Spencer and published in the 'Coalfield Memoir,' pp. 304-307. The section is reproduced here down to the Coal Measures. Ht. above O.D., 533 ft.

		Thickness		Depth	
		Ft.	In.	Ft.	In.
[Keuper]	Made ground ... ..	14	1	14	1
	Red clay ... ..	8	11	23	0
	New red [marl] soft ... ..	20	9	43	9
	New red [marl] ... ..	29	3	73	0
	New red [marl] soft ground ...	20	3	93	3
	New red [marl] with bands of white stone (water) ... ..	31	9	125	0
	New red [marl] with bands of white stone ... ..	24	4	149	4
	New red [marl] soft ground ...				
	New red [marl] with bands of stone (water) ... ..	26	5	175	9
	New red [marl] (much water) ...	6	0	181	9
	Strong white stone mixed with new red [marl] ... ..	7	6	189	3
	New red [marl] (two strong feeders of water) ... ..	7	9	197	0
	Strong new red [marl] with band of gypsum $\frac{3}{4}$ to $1\frac{1}{2}$ in. (water, 7,200 gallons per hour)...	38	2	235	2
	Strong white sandstone, 9 ft., and new red [marl] ... ..	30	8	265	10
	New red [marl] with bands of skerry ... ..	14	7	280	5
	Red marl ... ..	2	0	282	5
	Strong sandstone ... ..	3	0	285	5
	Red marl ... ..	1	0	286	5
	Soft sandstone (water) ... ..	0	6	286	11
	Soft red marl ... ..	12	5	299	4
[Coal Measures]	Conglomerate (water, 600 gallons per hour)...	2	0	301	4
	Soft rotten bind ... ..	2	0	303	4
	COAL and shale ... ..	1	0	304	4
	Measures and coals ... ..	657	0	961	4

#### ANALYSIS

Maynard Arms, close to Bagworth Railway Station. New well, sunk 1911 (30 ft. deep; 24 ft. to water) in Keuper Marl. By S. F. Burford.

	Grains per gallon
Date ... ..	11.9.12
Appearance in 2-ft. tube ... ..	Clear
Odour... ..	None
Reaction ... ..	—
Metals ... ..	—
Chlorine ... ..	3.16
Nitrites ... ..	None
Nitrogen as nitrates, etc. ... ..	None
Ammonia ... ..	None
Albuminoid ammonia ... ..	0.0089
Oxygen absorbed from permanganate in 15 min. at 80° Fahr. ... ..	0.0107
Total solids dried at 220° Fahr. ... ..	60.9
Hardness (degrees of Clark's Scale) :—	
Permanent ... ..	28
Temporary ... ..	22
Total ... ..	50
Microscopical examination of deposit ...	Satisfactory

*Remarks.*—This water may be used for drinking and for domestic purposes.

*Desford Colliery: No. 1 Pit* (commenced October, 1900). The following is a summarized section of No. 1 Shaft above the Coal Measures; the complete section is given in the 'Coalfield Memoir,' pp. 307-309. Ht. above O.D., 400 ft.

	Thickness	Depth
	Ft. In.	Ft. In.
Soil ... ..	1 6	1 6
[Keuper] { Red and white marls with gypsum ...	108 2	109 8
Honeycombed red marl from which comes a strong feeder of 100 gallons a minute (130° hardness)—the bulk of the total yield of the shaft... ..	2 0	111 8
Red marls and bands of sandstone ...	144 7	256 3
Breccia. A small feeder ... ..	6 0	262 3
Coal Measures ... ..	457 0	719 3

Total amount of water pumped during the year 1904 :—69,228,530 gallons.  
Duplex horizontal ram pumps. Water pure, but hardness 90°.

## ANALYSIS

*Desford Colliery.* Practically all the water is said to come from the Keuper. By S. F. Burford.

	Grains per gallon
Date ... ..	17.3.05
Appearance in 2-ft. tube ... ..	Clear, colourless
Odour when heated to 100° Fahr. ...	None
Chlorine ... ..	2.49
Nitrites ... ..	None
Nitrogen as nitrates, etc. ... ..	None
Ammonia ... ..	0.003
Albuminoid ammonia ... ..	0.0067
Oxygen absorbed by organic matter in 15 min. at 80° Fahr. ... ..	0.0032
Total solid matter dried at 220° Fahr. ...	130.9
Hardness (degrees of Clark's Scale) :—	
Temporary ... ..	15.0
Permanent ... ..	75.0
Total ... ..	90.0
Microscopical examination of deposit ...	Earthy



*Remarks.*—This water is organically pure. It is extremely hard and is saturated with saline salts.

**Barlestone**—Maps : 155 ; (29 N.E., S.E.)

*Kirkham's Well.*—Well sunk in March, 1925, at Mr. Kirkham's new house. Information from W. Keay.

				Thickness	Depth
				Ft.	Ft.
Glacial	{	Soil and sandy loam	... ..	6	6
		Running sand (water here)	... ..	3	9
Keuper Marl		Green marl	... ..	3	12

Rest level 3 ft. down ; supply ample. The water has a smell when standing, probably from decomposition of iron pyrites.

**Desford**—Maps : 155 ; (30 S.W., S.E., 36 N.W., N.E.)

Desford village is on the northern edge of a tract of Glacial sand and gravel that is underlaid by Keuper Marl.

*Well 150 yards north of the Church.* Information from W. Keay. Sunk 1923. Ht. above O.D., about 400 ft.

Red marl with bands of green marl and coarse sandstone 70 ft.

Water level from 49 to 53 ft. down. A  $\frac{1}{2}$  h.p. motor has lowered 15 ft. of water which fills again in 24 hours.

*Well* at two new houses at the top of the hill on the road from the Railway Station. Information from J. A. L. Beasley.

... Information from J. R. L. Deasy.

				Thickness	Depth
				Ft.	Ft.
[Glacial]	{	Loam and coarse gravel	... ..	4	4
		Red clay	... ..	8½	12½
		Hard phile	... ..	1	13½
		Red clay	... ..	3½	16¾
[Keuper Marl]	{	Mixed clay and red skerry	... ..	5¾	22½
		Red clay	... ..	2½	25
		Skerry	... ..	1	26
		Red clay (quite dry)	... ..	9¾	35¾
		Hard skerry (signs of water)	... ..	6	41¾
		Wet and signs of water	... ..	10¼	52

Water-level 48 ft. down ; supply good.

*Well* at house by the road at the foot of the hill near the Railway Station.

[Keuper] Marl ... .. 10 ft.

Water-level 7 ft. down ; supply fair.

*Well* at Brooke's new house, Station Road. Information from J. A. L. Beasley.

[Boulder] clay with sand vein in which water was encountered ... 18 ft.

Water-level 14 ft. down, supply good.

*City of Leicester Waterworks.*—Near the Railway Station is the Leicester Corporation's Pumping Station, which was erected in 1923, to pump Thornton-Reservoir water to Nuneaton.

*Lindridge Borings and Shaft.*

*Boring No. 1*, close to the Lodge at Lindridge Hall.<sup>1</sup> About 1875. From J. Plant's MSS. and published in the 'Coalfield Memoir,' p. 344 ; see also p. 103. Ht. above O.D., 325 ft.

<sup>1</sup> The 'Lindridge Hall Colliery Boring, Desford,' of C. E. De Rance, *Trans. Manchester Geol. Soc.* vol. xv, 1878, p. 96.

	Thickness		Depth	
	Ft.		Ft.	
Drift ... ..	2		2	
Upper Keuper Sandstone ... ..	20		22	
Red marl with thin bands of gypsum ... ..	44		66	
Lower Keuper Sandstone ... ..	204		270	
Slaty looking rock with red marls, dipping at angle of 70° ... ..	114		384	

Fox-Strangways says (p. 103) that the slaty looking rock was "supposed to be identical with those of Charnwood."

*Boring No. 2*, half-a-mile W. by 28° S. of No. 1, and at the south-west corner of the field south of the farm. About 1883. Section by H. Waugh from J. Plant's MSS. and published in the 'Coalfield Memoir,' p. 345.

	Thickness		Depth	
	Ft.		Ft.	
Keuper Sandstone ... ..	277		277	
Coal Measures ... ..	111½		388½	

The Coal Measures contain five seams of coal.

According to Fox-Strangways (*loc. supra cit.*, p. 167), in 1902 borings were put down close to the site of the older borings but he was unable to obtain the details.

*No. 3*, a shaft (417 ft.) and boring (90 ft.) a quarter-of-a-mile south of No. 1. Ht. above O.D., 325 ft. From J. Plant's MSS. and published in the 'Coalfield Memoir,' p. 345.

		Thickness		Depth	
		Ft.	In.	Ft.	In.
[Keuper Marl]	Upper gypseous series ...	50	2	50	2
	Grey skerry ... ..	6	6	56	8
	Lower gypseous series ...	86	10	143	6
[L. K. Sandstone]	Grey and red marly sandstone	114	6	258	0
[? Coal Measures]	Red marl with limestone ...	18	0	276	0
[Coal Measures]	Coal measures with four				
	seams of coal ... ..	231	0	507	0

The coal seams dip at from 45° to 60°.

*Newbold Heath Boring*.—Fox-Strangways says ('Coalfield Memoir,' p. 167) that a boring of which he was unable to obtain particulars was made on "Newbold Heath, half a mile W.S.W. of Lindridge, in which Coal-measures were found to a depth of 400 feet."

*Barron Park Farm Boring* (? Shaft) Site marked on map (Shaft) about half-a-mile west of Kirby Muxloe. 1830. Ht. above O.D., 263 ft. From Rev. W. Coleman's MSS. published in full in the 'Coalfield Memoir,' pp. 351, 352; see also p. 104.

		Thickness		Depth	
		Ft.	In.	Ft.	In.
Glacial (? all)	Sand, gravel, clay and marl...	39	9	39	9
Trias (? all)	{ Red marl with bands of stone and sandstone ...	78	9	118	6
Keuper Marl					
Pre-Cambrian	Charnwood Forest Rocks.				

### Groby—Maps : 155 ; (24 S.E., 30 N.E.)

Groby village is partly on Upper Keuper Marl overlying syenite, and partly on Glacial sand and gravel overlying the marl.

198 houses in the parish, of which 155 are in the village, are supplied with Leicester Corporation water.

According to Mr. Smith, well-sinker, wells near the School are from "36 to 50 feet into [Glacial] sand."

*Groby Pool*.—This 'pool' is the largest natural sheet of water in the county.

**Ibstock**—Maps: 155; (23 S.W., S.E., 29 N.E.)

Coal Measures occur at the surface in the valley from Heather Railway Station northwards. They are overlaid by Lower Keuper Sandstone on which the greater part of the village of Ibstock is situated, but the greater part of the parish is on Upper Keuper Marl. Locally Boulder Clay and (underlying) Glacial sand overlies the 'solid' rocks. At Ellistown Colliery the surface of the Coal Measures is at 362 ft. 9 in. down (see below).

The parish of Ibstock is on ground sloping from the east, at an elevation of about 582 ft. above Ordnance Datum near Ellistown Colliery, down to the west to 370 ft. near the Sewage Farm. The district is divided into three parts by two streams which join at the Sewage Farm. At present the majority of the population obtain water from numerous shallow wells of depths varying from 20 to 60 ft. or thereabouts. In a few instances water from surface springs are available, and the houses in Ellistown are supplied by the Colliery Company.

*Ibstock Spring*.—There are small springs in Spring Road. On 26th June, 1924, the spring near Ibstock Lodge, near the Black Swan Inn, was gauged (by W. Keay) at 18,000 gallons per day, and that half-a-mile to the east at 20,000 gallons per day. There are also several small springs, in the Black Swan Inn Valley. All these springs issue from the Lower Keuper Sandstone.

*Ellistown Colliery*.—1874-76. Ht. above O.D., 560 ft. Detailed record from E. D. Spencer published in the 'Coalfield Memoir,' pp. 299-302; see also p. 108.

		Thickness		Depth	
		Ft.	In.	Ft.	In.
[Keuper Marl and Lower Keuper Sandstone]	Soil, marl, and skerry ...	190	0	190	0
	Skerry ...	1	0	191	0
	Marl... ..	4	3	195	3
	Skerry ...	1	0	196	3
	Marl... ..	8	9	205	0
	Skerry ...	6	0	211	0
	Marl... ..	22	9	233	9
	Sandstone rock ...	1	0	234	9
	Marl... ..	5	0	239	9
	Skerry ...	1	0	240	9
	Marl... ..	5	0	245	9
	Marl mixed with skerry ...	10	0	255	9
	Marl... ..	0	7	256	4
	Skerry ...	1	0	257	4
	Sandstone rock ...	6	2	263	6
	Marl... ..	1	2	264	8
	Marl and skerry ...	5	6	270	2
	Skerry ...	1	0	271	2
	Marl... ..	8	9	279	11
	Skerry ...	1	0	280	11
	Marl... ..	4	0	284	11
	Sandstone rock ...	5	3	290	2
	Marl... ..	9	6	299	8
	Conglomerate ...	8	4	308	0
	Marl... ..	3	6	311	6
	Rock ...	7	7	319	1
	Bind ...	4	0	323	1
	Bat ...	1	7	324	8
	Coal? [said to be an error] ...	0	4	325	0
	Clunch ...	6	6	331	6
	Bind ...	1	6	333	0
	Clunch ...	4	1	337	1
Coal Measures	Whinstone rock ...	25	8	362	9
	... ..	633	5	996	2



400,000 gallons of water, practically all from the Lower Keuper Sandstone, are pumped daily from this colliery (analysis below).

## ANALYSIS

*Ellistown Colliery.*—This water, from the Lower Keuper Sandstone pierced by the shaft, was used for many years as a supplementary supply for the City of Leicester and was only discontinued when the supply from the Derwent Valley was obtained. By S. F. Burford.

						Parts per 100,000
Date ...	...	...	...	...	...	2.4.24
Appearance in 2-ft. tube ...	...	...	...	...	...	Colourless
Odour...	...	...	...	...	...	None
Reaction ...	...	...	...	...	...	Faintly alkaline
Metals ...	...	...	...	...	...	None
Chlorine ...	...	...	...	...	...	2.81
Nitrites ...	...	...	...	...	...	None
Nitrogen as nitrates, etc. ...	...	...	...	...	...	None
Ammonia ...	...	...	...	...	...	0.0010
Albuminoid ammonia ...	...	...	...	...	...	0.0120
Oxygen absorbed from permanganate in						
15 min. at 80° Fahr. ...	...	...	...	...	...	None
Total solids dried at 220° Fahr. ...	...	...	...	...	...	65.0
Hardness (degrees of Clark's Scale) :—						
Permanent ...	...	...	...	...	...	24.0
Temporary ...	...	...	...	...	...	9.0
Total ...	...	...	...	...	...	33.0
Microscopical examination of deposit ...	...	...	...	...	...	Satisfactory

*Remarks.*—This water is organically pure and may be used for drinking. It is hard but may be rendered soft by boiling.

*Ibstock Colliery.*

1.—Old Pit sunk by Thirlby to the Coal No. 26 in 1825. Ht. above O.D., about 470 ft. No. 2 of Sheet 19 of the Vertical Sections of the Geological Survey. A detailed record from the Rev. W. Coleman's MSS. is given in the 'Coalfield Memoir,' pp. 288, 289.

2.—No. 2 Pit. 1840. Ht. above O.D., about 470 ft. A detailed record from G. Lewis, with additions from the Rev. W. Coleman's MSS. is given in the 'Coalfield Memoir,' pp. 289, 290.

Summarized sections :—		1				2			
		Thickness		Depth		Thickness		Depth	
		Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Keuper Marl and Sandstones	Soil and clay ...	2	9	2	9	2	0	2	0
	Red marl with sandstone beds	121	9	124	6	132	3	134	3
	Crossil or Crossle bed (conglomerate)...	2	0	126	6	3	0	137	3
	Red and purple bind ...	3	0	129	6	2	2	139	5
	Blue bind (and other beds in Old Pit) ...	8	6	138	0	—	—	—	—
	Brown rock (much water in No. 2 Pit) ...	5	11	143	11	9	0	148	5
Coal Measures	Bind ...	20	0	163	11	13	8	162	1
	COAL ...	1	0	164	11	1	0	163	1
	Measures and seams of coal	219	4	384	3	284	2	447	3

Approximate quantity of water pumped daily, 250,000 gallons. (W. Keay).

## ANALYSES

1.—Ibstock Colliery.—Practically all the water pumped down from this colliery comes from the Lower Keuper Sandstone. 2.—Springs from Lower Keuper Sandstone near Ibstock Lodge near the Black Swan Inn.

By S. F. Burford.

						Parts per 100,000	
						1	2
Date	...	...	...	...	...	18.5.24	2.4.24
Appearance in 2-ft. tube	...	...	...	...	...	Very turbid	Clear :
							colourless
Odour	...	...	...	...	...	None	None
Reaction	...	...	...	...	...	Faintly alkaline	Faintly alkaline
Metals	...	...	...	...	...	None	None
Chlorine	...	...	...	...	...	6.24	1.65
Nitrites	...	...	...	...	...	None	None
Nitrogen as nitrates, etc.	...	...	...	...	...	None	0.23
Ammonia	...	...	...	...	...	0.0064	None
Albuminoid ammonia	...	...	...	...	...	0.0164	0.0216
Oxygen absorbed from permanganate in 15 min. at 80° Fahr.	...	...	...	...	...	0.1616	None
Total dried solids at 220° Fahr.	...	...	...	...	...	138.0	58.0
Hardness (degrees of Clark's Scale) :—							
Permanent	...	...	...	...	...	27.0	14.0
Temporary	...	...	...	...	...	11.0	10.0
Total	...	...	...	...	...	38.0	24.0
Microscopical examination of deposit	...	...	...	...	...	Earthy	Slight : some diatoms

*Remarks.*—1.—This is water of inferior quality. It is very hard and should not be used for drinking unless it has been previously boiled or passed through a sterilizing filter. 2.—Organically pure but hard.

**Kirkby Mallory**—Maps : 155 ; (30 S.W., 35 N.E., 36 N.W.)

*Well*, sunk 1911, near road 500 yards due north of the Church, 3½ ft. inside diameter ; 4½ ft. brickwork. Information from W. Keay.

						Thickness	Depth
						Ft.	Ft.
Glacial	{	Gravel	...	...	...	10	10
		Red clay with stones	...	...	...	6	16
		Loamy sand	...	...	...	9	25

Water stands 9 ft. 9 in. deep.

Water rose : 1 ft. in 2 hrs. ; 2 ft. in 4 hrs. ; 2½ ft. in 6 hrs. ; 3 ft. in 8 hrs. ; and after the well was emptied the water rose 5½ ft. in 24 hrs.

**Market Bosworth**—Maps : 155 ; (29 S.W., S.E., 35 N.W., N.E.)

*Bosworth Wharf Boring.*—Site marked on map—close to canal at railway station. 1880-1882. Ht. above O.D., 300 ft.

Detailed record from J. Plant's MSS. published in the 'Coalfield Memoir,' pp. 342-343 ; see also pp. 102, 103. H. T. Brown, *Quart. Journ. Geol. Soc.*, vol. xlv, 1889, pp. 31, 32, 37, 38.

						Thickness	Depth
						Ft.	Ft.
<i>Summarized section :—</i>							
Boulder Clay...	...	...	...	...	...	27	27
Keuper Marl	...	...	...	...	...	355	382
Lower Keuper Sandstone	...	...	...	...	...	179	561
Bunter Pebble Beds with, below	...	...	...	...	...	183	744
[? Trias] Breccia	...	...	...	...	...	10	754

		Thickness	Depth
		Ft.	Ft.
Cambrian (Stockingford Shales)	Igneous rock ... ..	43	797
	Dark ferruginous shales dipping at a high angle ... ..	454	1251
	Igneous rock ... ..	57	1308
	Shales with thin igneous bands ...	22	1330
	Breccia ... ..	34	1364

Dr. Brown stated that the breccia is composed principally of fragments of slate and igneous rock, embedded in a hard calcareous matrix resembling very much in general appearance the breccia which occurs at the base of the Hartshill Quartzite (Cambrian). He considered that this boring passed through a fault, which throws up the basement beds of the Hartshill Quartzite on the east against the Stockingford Shales on the west, as the shales passed through in the boring are not the Lower Stockingford Shales, and shales of this character are not found abruptly succeeding breccias without any sign of a passage. Moreover, the beds were much broken and slickensided just before the breccia was reached.

*Cowpasture Boring.*—Site marked on map; 800 yards due N.E. of the Church at Market Bosworth. Commenced July 1878. Ht. above O.D., about 380 ft.

From J. Plant's MSS. with additions in curved brackets from Dr. H. T. Brown published in the 'Coalfield Memoir,' pp. 102, 344. H. T. Brown, *Quart. Journ. Geol. Soc.*, vol. xlv, 1889, p. 31; see also p. 37.

		Thickness	Depth
		Ft.	Ft.
[Glacial]	Boulder-clay ... ..	40	40
[Trias]	{ Red marl and sandstone ... ..	299	339
	{ Bunter [?] sandstone ... ..	39	378 (380)
[? Trias]	Breccia (53) ... ..	50	428
[Cambrian]	Slaty rock (Stockingford Shales, 112 ft.) ... ..	119	547 (545)

(At 500 ft. a bed of igneous rock is said to have been passed through).

Specimens of the rock at 467 feet, a fine grey slate, and at 509 a much decomposed diorite, are in the Geological Survey Collection. Nos. 2775, 2776.

*Kingshill Spinney Boring.*—Site shown on map just north of the Kingshill Spinney, and about  $1\frac{3}{4}$  miles south-west of Market Bosworth. 1880-82. Ht. above O.D., about 300 ft.

From a diagram amongst J. Plant's MSS. and published in the 'Coalfield Memoir,' p. 344; see also p. 103. H. T. Brown, *Quart. Journ. Geol. Soc.*, vol. xlv, 1889, p. 32.

	Thickness <sup>1</sup>	Depth
	Ft.	Ft.
Boulder-clay and sands ... ..	126	126
Keuper Marl ... ..	246	372
Keuper sandstone ... ..	322	694
Bunter conglomerate and sands ...	124	818
Breccia ... ..	30	848
Carboniferous [? probably Stockingford Shales] ...	206	1054

Dr. H. T. Brown stated that this boring was sunk entirely in the Trias and that there was a considerable thickness of beds supposed to be Bunter at the bottom. J. Plant gives a different account stating that, although there was a considerable thickness of Bunter, the lower part was in shales said to be Carboniferous, but more probably Silurian.

<sup>1</sup> Thicknesses only approximate.



**Nailstone**—Maps: 155; (23 S.E., 29 N.E., S.E.)

*Nailstone Colliery.*—No. 2 Shaft (upcast). Information from J. Povey Harper and published in the 'Coalfield Memoir,' pp. 297-299. This section is reproduced below only down to the Coal Measures. Ht. above O.D., 500 ft.

		Thickness		Depth	
		Ft.	In.	Ft.	In.
[Keuper Marl and sandstones]	Red marl and skerries ...	180	0	180	0
	Light blue sandstone rock ...	12	0	192	0
	Marl and skerries ...	60	0	252	0
	Conglomerate or Crossle bed ...	5	0	257	0
[? Keuper]	Pink and purple bind ...	6	0	263	0
[Coal]	Blue bind ...	42	0	305	0
Measures]	COAL ...	1	9	306	9
	Measures with coal seams ...	542	11	849	8

Approximate quantity of water pumped daily, 90,000 gallons. (W. Keay).

## ANALYSIS

*Nailstone Colliery.* Practically all the water pumped from this quarry is said to come from the Keuper. By S. F. Burford.

					Parts per 100,000
Date ...	...	...	...	...	26.4.24
Appearance in 2-ft. tube ...	...	...	...	...	Whitish turbidity
Odour... ..	...	...	...	...	None
Reaction ... ..	...	...	...	...	Faintly alkaline
Metals ... ..	...	...	...	...	None
Chlorine ... ..	...	...	...	...	5.33
Nitrites ... ..	...	...	...	...	None
Nitrogen as nitrates, etc. ...	...	...	...	...	None
Ammonia ... ..	...	...	...	...	0.0425
Albuminoid ammonia ... ..	...	...	...	...	0.0180
Oxygen absorbed from permanganate in	...	...	...	...	
15 min. at 80° Fahr. ... ..	...	...	...	...	0.0538
Total solids dried at 220° Fahr. ...	...	...	...	...	183.0
Hardness (degrees of Clark's Scale) :—					
Permanent ... ..	...	...	...	...	55.0
Temporary ... ..	...	...	...	...	26.5
Total ... ..	...	...	...	...	81.5
Microscopical examination ... ..	...	...	...	...	Mineral only

*Remarks.*—This is a contaminated water which is not fit for drinking. It is excessively hard and not fit for boilers.

**Newbold Verdon**—Maps: 155; (29 N.E., S.E., 30 N.W., S.W., 35 N.E.)

'*Newbold Verdon Boring.*'—From Rev. W. Coleman's MSS. and published in the 'Coalfield Memoir,' p. 348. Ht. above O.D., about 400 ft.

		Thickness		Depth	
		Ft.		Ft.	
Sand and marl ... ..	...	57		57	
Red marl with partings of gypsum ...	...	216		273	
Grey rock ... ..	...	2½		275½	
Marl and gypsum ... ..	...	21½		297	
Marl and sand ... ..	...	26		323	
Grey rock ... ..	...	4½		327½	
Pink and purple [marl] ... ..	...	15½		342½	
Hard grey, grozzly bed ... ..	...	17½		360	
Soft parting ... ..	...	0½		360½	
Hard rock with red and blue partings ...	...	7¾		368¾	

'Gabriel Pool Boring.'—Fox-Strangways says ('Coalfield Memoir,' p. 167): "Near Gabriel Pool, three-quarters of a mile N.N.W. of Newbold Verdon [a boring of which it was not possible to obtain details was made] to a depth of 266 ft."

**Peckleton**—Maps: 155; (30 S.W., 36 N.W., S.W.)

*Desford Boring.*—Near Stocks House Farm, Peckleton. 1904. Ht. above O.D., 400 ft. Communicated by H. S. Dunn and published in the 'Coalfield Memoir,' p. 347.

		Thickness		Depth	
		Ft.	In.	Ft.	In.
Glacial	Soil ... ..	1	6	1	6
	Red clay and stones ... ..	38	6	40	0
	Red marl ... ..	53	4	93	4
	Red marl with gypsum veins and grey bands ... ..	144	8	238	0
Keuper Marl and Sandstone	Red and blue marl ... ..	30	0	268	0
	Conglomerate ... ..	0	6	268	6
	Red and blue marl ... ..	33	6	302	0
	Red sandstone ... ..	8	0	310	0
	Red sandstone and thin bands of marl ... ..	62	0	372	0
	Red sandstone ... ..	6	0	378	0
	Coarse grey sandstone ... ..	7	0	385	0
	Red sandstone and thin bands of marl ... ..	16	0	401	0
	Purple marl ... ..	11	0	412	0
	Dark grey sandstone ... ..	2	0	414	0
	Conglomerate ... ..	4	0	418	0
	Soft red marl ... ..	1	0	419	0
	Coarse grey sandstone ... ..	4	0	423	0
	Red marl ... ..	1	2	424	2
	Conglomerate ... ..	0	10	425	0
	Light grey sandstone ... ..	1	6	426	6
	Soft red marl ... ..	3	6	430	0
	Strong red marl ... ..	2	0	432	0
	Coarse grey sandstone ... ..	9	0	441	0
	Red sandstone and thin bands of marl ... ..	12	0	453	0
Millstone Grit	Coarse grey sandstone ... ..	3	6	456	6
	Conglomerate ... ..	1	6	458	0
	Red marl ... ..	2	0	460	0
	Dark grey sandstone ... ..	1	0	461	0
	Red and grey sandstone ... ..	2	0	463	0
	Mottled marl ... ..	4	0	467	0
	Light grey sandstone ... ..	5	0	472	0
	Grey sandy metal and spar ... ..	3	0	475	0
	Conglomerate [Carboniferous Limestone with <i>Productus giganteus</i> ] ... ..	8	0	483	0
	Light blue sandstone ... ..	10	0	493	0
Carboniferous Limestone	Coarse grey sandstone ... ..	3	0	496	0
	Conglomerate ... ..	1	0	497	0
	Brown sandstone ... ..	2	6	499	6
	Whinstone or soft granite ... ..	37	6	537	0

W. Gibson, who examined the cores from this boring some weeks after they were drawn, states that "below 372 feet the cores had been lying open in the field and consequently were out of order in places. The sinker's account does not in many cases intelligibly describe the rocks."

*Ligula mytiloides* and scales of *Rhizodopsis* were found in the cores below 372 feet, but there is no evidence to show what portion of the strata between that and 460 feet belong to the Coal Measures.

This boring is interesting as showing that both the Millstone Grit and the Carboniferous Limestone, although much attenuated, are still present beneath the Coal Measures. This is the furthest south that these beds have as yet been proved in this part of the county.

**Ratby**—Maps : 155 ; (30 N.W., N.E., S.W., S.E.)

49 houses in Ratby village and 18 in the Newtown Unthank and Botcheston district are supplied with Leicester water.

*Holy Well*.—This well—marked on the map—is at Holy Well House, south-east of the ancient encampment known as Bury Camp. It is a good spring, “never been known to freeze,” that appears to be the product of the drainage of a gravel tract resting on Keuper Marl, but may have a deeper-seated origin. The water has been piped into a now well-kept pond in the grounds of Holy Well House. In days gone by the water obtained some notoriety in connexion with the treatment of scorbutic diseases.

*Newtown Unthank Boring*.—Site marked on map. 1874. Ht. above O.D., 280 ft. The following section is from J. Plant’s MSS. and is given in the ‘Coalfield Memoir,’ pp. 345-347, but the classification suggested below has been in part based on that given by G. P. Browne in *Rep. Brit. Assoc.* for 1878 (1879) p. 388.

		Thickness		Depth	
		Ft.	In.	Ft.	In.
Boring (diameter, 7 in.) :—					
[Glacial ? 6 ft.]	Drift [6 ft. in <i>Rep. Brit. Assoc.</i> ]	48	0	48	0
[Keuper Marl]	Red marl with skerries and gypsum ... ..	172	4	220	4
	Hard rock with partings yielding water ... ..	15	6	235	10
	Blue rock marl ... ..	3	0	238	10
	Blue marl ... ..	5	0	243	10
[Lower Keuper Sandstone]	Red sandstone rock yielding water ... ..	6	3	250	1
	Hard rock with marl partings ... ..	10	9	260	10
	Rock marl ... ..	2	6	263	4
	Red sandstone rock yielding water ... ..	22	9	286	1
	Red sandstone rock with marl partings yielding water ... ..	29	6	315	7
	Red marl ... ..	2	0	317	7
	Rocky marl and rock yielding water ... ..	14	0	331	7
	Hard, red sand, jointy stone, rock yielding water ... ..	4	6	336	1
	Rock and rock marl ... ..	15	6	351	7
	Strong rocky marl ... ..	24	0	375	7
[? Coal Measures]	... ..	242	2	617	9

Fox-Strangways says (p. 104) : “. . . Coal-measures . . . [are] said to have been reached at 376 feet,<sup>1</sup> although no coal was met with ; it is very doubtful what these lower beds really were, but it is evident that they do not extend far and are soon cut off to the east, as in the boring or shaft at Barron Park, between here and Kirby Muxloe, igneous rocks were met with at a depth of only 118 feet.”

<sup>1</sup> The account in *Rep. Brit. Assoc.* for 1878 (1879), p. 388, is erroneous in that it gives the total thickness of the Trias as only 256 ft.



According to G. P. Browne (*Rep. Brit. Assoc. for 1878*, p. 388) water "runs over the top [of the borehole], and was first struck at 220 ft. deep."

*Shackerstone Boring*.—No. 3 Trial boring for coal made by Messrs. A. C. Potter & Co., Grantham, February—13th July, 1920, on Gopsall Estate (in Field 162, Leicestershire 29, 6). Site close to stream just within Odstone parish some 500 yards N. by E. of Shackerstone Station.

Boring (diameter, 10½ in. to 556 ft., 9½ in. to 600 ft.) :—

	Thickness		Depth	
	Ft.	In.	Ft.	In.
Alluvial :—				
Soil ... ..	0	6	0	6
Clay ... ..	1	6	2	0
Gravel ... ..	3	0	5	0
Clay ... ..	0	6	5	6
Clay and gravel ... ..	2	6	8	0
Keuper Marl :—				
Clay, blue ... ..	0	6	8	6
Clay, red ... ..	9	6	18	0
Clay, blue ... ..	0	3	18	3
Clay, red ... ..	1	9	20	0
Clay, blue and red ... ..	1	0	21	0
Clay and gravel [?] ... ..	0	4	21	4
Clay, blue and red with gypsum ... ..	1	8	23	0
Clay, hard, red ... ..	7	0	30	0
Clay, very hard, red ... ..	5	0	35	0
Hard red clay with gypsum ... ..	1	0	36	0
Hard red clay ... ..	2	0	38	0
Hard sandy clay ... ..	4	6	42	6
Dark grey sandstone ... ..	0	9	43	3
Red sandy clay and gypsum ... ..	2	6	45	9
Grey sandstone and gypsum ... ..	0	3	46	0
Soft sandy clay ... ..	3	6	49	6
Gypsum ... ..	0	5	49	11
Red sandy marl ... ..	4	1	54	0
Red sandy marl ... ..	1	0	55	0
Bluish marly sandstone ... ..	3	0	58	0
Red marly sandstone ... ..	9	0	67	0
Very soft sandy marl ... ..	3	0	70	0
Red marly sandstone ... ..	4	0	74	0
Soft blue and shaly marl ... ..	4	0	78	0
Lower Keuper Sandstone and Bunter :—				
Blue and red shaly sandstone ... ..	2	6	80	6
Red shaly sandstone ... ..	3	6	84	0
Red marl ... ..	0	2	84	2
Red shaly sandstone ... ..	3	4	87	6
Gypsum ... ..	0	1	87	7
Red shaly sandstone ... ..	6	5	94	0
Hard red shaly sandstone with trace of gypsum ... ..	15	0	109	0
Hard red shaly sandstone ... ..	3	6	112	6
Hard dark grey and red sandstone ... ..	6	0	118	6
Red shaly sandstone with trace of gypsum ... ..	5	6	124	0
Red shaly sandstone ... ..	3	6	127	6
Hard grey sandstone ... ..	6	6	134	0
Red shaly sandstone ... ..	5	0	139	0
Dark grey sandstone ... ..	1	6	140	6
Dark grey sandstone ... ..	0	8	141	2
Red shaly sandstone with thin layers of grey sandstone ... ..	7	1	148	3
Marl ... ..	0	2	148	5

	Thickness		Depth	
	Ft.	In.	Ft.	In.
Marly sandstone ... ..	7	10	156	3
Red and grey sandstone ... ..	10	9	167	0
Hard grey sandstone ... ..	6	0	173	0
Hard grey sandstone ... ..	4	0	177	0
Red and blue clay ... ..	0	2	177	2
Red and grey sandstone ... ..	7	10	185	0
Red and grey sandstone ... ..	10	6	195	6
Red marly sandstone ... ..	6	6	202	0
Hard grey sandstone ... ..	5	6	207	6
Hard grey sandstone ... ..	8	0	215	6
Red marly sandstone ... ..	0	6	216	0
Hard grey sandstone ... ..	6	0	222	0
Red marly sandstone ... ..	27	0	249	0
Hard red marly sandstone ... ..	13	0	262	0
Hard grey sandstone ... ..	12	4	274	4
Hard red marly sandstone ... ..	4	1	278	5
Hard red marly sandstone ... ..	13	1	291	6
Red and grey sandstone ... ..	7	10	299	4
Soft grey sandstone ... ..	3	2	302	6
Red marly sandstone ... ..	1	0	303	6
Grey sandstone... ..	0	6	304	0
Red marly sandstone ... ..	3	0	307	0
Red marly sandstone ... ..	2	10	309	10
Grey sandstone... ..	1	2	311	0
Red marly sandstone ... ..	1	9	312	9
Soft grey sandstone ... ..	9	0	321	9
Red and grey sandstone ... ..	1	9	323	6
Soft grey sandstone ... ..	4	6	328	0
Grey sandstone... ..	2	4	330	4
Red marl and grey sandstone ... ..	1	7	331	11
Red sandy marl ... ..	2	6	334	5
Red marl [ & ] grey sandstone ... ..	2	7	337	0
Red and blue marl ... ..	4	8	341	8
Grey sandstone... ..	2	0	343	8
Red marl ... ..	0	6	344	2
Grey sandstone... ..	2	6	346	8
Red marl and grey sandstone mixed ... ..	4	4	351	0
Red marl ... ..	4	1	355	1
Grey sandstone ... ..	0	6	355	7
Red sandstone ... ..	0	10	356	5
Red sandstone ... ..	1	0	357	5
Grey sandstone... ..	0	8	358	1
Red sandstone ... ..	0	7	358	8
Red marl ... ..	7	11	366	7
Blue marl ... ..	0	1	366	8
Red marl ... ..	0	4	367	0
Blue marl ... ..	0	0 $\frac{1}{2}$	367	0 $\frac{1}{2}$
Red marl ... ..	0	10	367	10 $\frac{1}{2}$
Blue marl ... ..	0	0 $\frac{1}{2}$	367	11
Red marl ... ..	0	5	368	4
Blue marl ... ..	0	1	368	5
Red marl ... ..	0	11	369	4
Blue marl ... ..	0	1	369	5
Grey sandstone... ..	4	7	374	0
Red marl ... ..	0	2	374	2
Grey sandstone... ..	0	5	374	7
Blue and red sandstone ... ..	0	6	375	1

	Thickness		Depth	
	Ft.	In.	Ft.	In.
Red marl ... ..	0	6	375	7
Red and blue sandstone ... ..	1	0	376	7
Grey sandstone... ..	0	10	377	5
Grey sandstone... ..	4	11	382	4
Red and blue marl ... ..	1	2	383	6
Grey sandstone... ..	1	1	384	7
Red marl ... ..	0	5	385	0
Red sandstone ... ..	0	4	385	4
Red marl, very soft ... ..	3	0	388	4
Blue and red marl with pebbles ... ..	0	6	388	10
Red sand and conglomerate ... ..	4	2	393	0
Grey and red sand, very soft ... ..	4	0	397	0
Grey with band of red sandstone ... ..	5	0	402	0
Grey sandstone... ..	4	4	406	4
Conglomerate ... ..	2	0	408	4
Soft red marl ... ..	0	8	409	0
Grey and red sandstone ... ..	2	8	411	8
Conglomerate ... ..	3	4	415	0
Grey sandstone... ..	0	6	415	6
Red and blue marl and sandstone ... ..	0	4	415	10
Grey sandstone streaked with red ... ..	0	8	416	6
Grey sandstone with pebbles ... ..	0	5	416	11
Grey and red sandstone ... ..	0	9½	417	8½
Red marl, blue in places ... ..	0	6	418	2½
Red marl ... ..	0	7½	418	10
Sandstone ... ..	0	4	419	2
Red marl and sandstone ... ..	0	10	420	0
Grey sandstone ... ..	2	0	422	0
Red marl ... ..	1	3	423	3
Grey sandstone... ..	6	9	430	0
Grey sandstone... ..	5	0	435	0
Grey sandstone... ..	1	9	436	9
Conglomerate ... ..	2	0	438	9
Rough brown sandy grit ... ..	16	6	455	3
Grey sandstone and stones ... ..	2	9	458	0
Grey sandstone enclosing stones ... ..	7	0	465	0
[? Loose stones] ... ..	3	0	468	0
Conglomerate ... ..	9	0	477	0
Conglomerate ... ..	4	6	481	6
Conglomerate ... ..	3	0	484	6
Conglomerate ... ..	3	6	488	0
Conglomerate ... ..	3	6	491	6
Grey sandstone... ..	1	6	493	0
Grey sandstone... ..	4	0	497	0
Conglomerate ... ..	2	0	499	0
Conglomerate ... ..	0	6	499	6
Grey sandstone... ..	7	6	507	0
Grey sandstone... ..	3	6	510	6
Conglomerate ... ..	2	0	512	6
Red marly sandstone and pebbles ... ..	6	6	519	0
? Keele Group (Upper Coal Measures) :—				
Soft sandy marl ... ..	1	0	520	0
Red and grey sandstone ... ..	8	0	528	0
Red sandstone ... ..	2	0	530	0
Red marly sandstone and pieces of stone ... ..	2	0	532	0
Red sandstone ... ..	6	0	538	0
Red and grey sandstone ... ..	7	0	545	0



				Thickness		Depth	
				Ft.	In.	Ft.	In.
Soft red shaly sandstone	...	...	...	3	0	548	0
Soft dark shaly sandstone	...	...	...	8	0	556	0
Red and grey sandstone	...	...	...	16	0	572	0
[No record]	...	...	...	7	0	579	0
Hard dark red shale inclined to be marly	...	...	...	7	6	586	6
Hard dark red marly shale	...	...	...	8	0	594	6
Hard dark and marly shale	...	...	...	5	6	600	0

Water overflowing.

#### ANALYSIS

Made by T. Gordon Kelly, 26.4.1928

Reaction	...	...	...	...	Alkaline
Aeration...	...	...	...	...	Good
Hardness	...	...	...	...	A hard water
					Parts per 100,000
Chlorine	...	...	...	...	2.1
Free ammonia	...	...	...	...	0.003
Albuminoid ammonia	...	...	...	...	0.007
Nitrogen (from nitrates and nitrites)	...	...	...	...	traces
Nitrites	...	...	...	...	absent

*Opinions* :—This water is of good standard of organic purity and is fit for drinking.

Unfortunately no information is available from a competent geologist as to the classification of the strata.

**Sibson**—Maps : 155 ; (28 S.E., 29 S.W., 34 N.E., 35 N.W.)

*Natsopa Memorial Home*,<sup>1</sup> Wellsborough, boring at. ? 1921. Ht. above O.D., about 390 ft.

				Thickness		Depth	
				Ft.		Ft.	
[Glacial sand and gravel and Boulder Clay]	{	Loamy sand	...	15		15	
		Stiff red clay	...	2		17	
		Blue clay	...	29		46	
		Red clay and pieces of sandstone	...	18		64	
[Keuper Marl]	{	Red marl and sand rock	...	4		68	
		Gypsum and red marl	...	42		110	
		Red marl and ironstone	...	70		180	
		Hard grey rock	...	3		183	
		Marl and gypsum	...	1		184	
		Grey rock	...	7		191	
		Marl and gypsum	...	5		196	
		Grey rock	...	3		199	
		Hard grey rock	...	6		205	
		Marl and gypsum	...	10		215	
		Grey rock	...	3		218	
		Marl and gypsum	...	3		221	
		Marl, rock and gypsum	...	29		250	

Lined with 8-inch tubing. Yield approximately 200 gallons an hour. Water organically pure but extremely hard.

Boring made by, and information from, Messrs. Alfred Williams & Co., Artesian Works, 814, Old Ford Road, Bow, London, E.

<sup>1</sup> Formerly Temple Hall, Wellsborough.

**Thornton**—Maps : 155 ; (24 S.W., 30 N.W., S.W.)

Part of this parish is supplied by an undertaking belonging to the Warwick Estates Co., Ltd., from a spring from Glacial sand and gravel resting on Keuper Marl situate three-sixteenths of a mile north of the church, Bagworth (under the 'a' of Bagworth on the 1-inch Geological Survey map, Sheet 155). Yield not known. No filtration; no reservoir. The quantity of water supplied is ample and the quality good.

In this parish is the Thornton Reservoir of the Leicester Corporation; also Bagworth Moats, a site referred to by J. B. Everard as one on which an auxiliary supply to the Thornton Reservoir could be collected (see p. 135).

**Twycross**—Maps : 155 ; (28 N.E., S.E., 29 S.W.)

*Twycross Lodge.* Boring near. 1908. Ht. above O.D., 415 ft.

		Thickness		Depth	
		Ft.	In.	Ft.	In.
[Glacial]	1. Made ground ... ..	2	3	2	3
	2. Red sand and stones ... ..	11	3	13	6
	3. Bluish red marl and stone ... ..	15	6	29	0
	4. Red marl and bands of grey sandstone ... ..	86	6	115	6
	5. Ditto and gypsum ... ..	20	6	136	0
	6. Grey sandstone ... ..	1	6	137	6
	7. Red and grey marl and gypsum and grey sandstone ... ..	38	10	176	4
	8. Grey sandstone ... ..	3	6	179	10
	9. Red marl, gypsum, and bands of grey sandstone ... ..	12	2	192	0
	10. Grey sandstone ... ..	8	8	200	8
[Keuper Marl, Lower Keuper Sandstone and ? Bunter]	11. Red marl, gypsum, and grey sandstone in bands ... ..	214	10	415	6
	12. Red sandstone ... ..	3	9	419	3
	13. Red sandy marl ... ..	5	7	424	10
	14. Red marl, gypsum, and bands of red sandstone ... ..	4	6	429	4
	15. Hard fine red marly sandstone ... ..	5	5	434	9
	16. Red marl and thinner bands of sandstone ... ..	5	3	440	0
	17. Red and grey marl and bands of sandstone ... ..	8	0	448	0
	18. Sandstone ... ..	1	0	449	0
	19. Fine marly sandstone and bands of red marl ... ..	3	6	452	6
	20. Red and grey marl and bands of sandstone [with, it is said, traces of gypsum at 456 ft.] ... ..	4	0	456	6
	21. Fine red marly sandstone and bands of red marl ... ..	25	9	482	3
	22. Hard fine red sandstone ... ..	1	6	483	9
	23. Hard fine red sandstone and thin beds of red marl ... ..	6	9	490	6
	24. Fine red sandstone ... ..	1	0	491	6
	25. Fine red marly sandstone and bands of red marl [with, it is said, traces of gypsum at 509 ft.] ... ..	22	9	514	3
The bore was continued to 700 ft., passing through some gypsum between 637 and 664 ft.; sandstone of coarser texture at 676 ft., but finer below ... ..		—		700	0

Diameter of bore, 3 in. Water-level (standing), 169 ft. down. Yield 2,700 gallons an hour (lowers water-level  $1\frac{1}{2}$  ft.).

When the borehole was 514 $\frac{1}{4}$  ft. deep the water stood at about 150 ft. down, but the yield was not a pint per minute.

Boring by, and information from, Messrs. Le Grand, Sutcliff & Gell, Ltd.

### MARKET HARBOROUGH RURAL DISTRICT

This district is floored, as regards 'solid' rocks, with Lower Lias except for comparatively small areas the chief of which are :—(1) at and in the vicinity of Gumley where there is an outlier of Middle Lias faulted against Lower Lias along its north-western side; (2) at Market Harborough, where Middle Lias occurs capped locally with Upper Lias (Great Bowden is for the most part on Upper Lias); and (3) in the area in which are situate Cranoe and Slawston, which is on part of the main escarpment of the Middle Lias that is capped locally with Upper Lias.

Covering considerable portions of the 'solid' rocks are deposits of Glacial Boulder Clay, gravel, and sand.

Certain houses in Theddingworth and Lubenham obtain water from the Market Harborough District Council's main which passes through these villages, and Foxton has a small undertaking, but otherwise the villages in the district—the majority of which are situate on Glacial gravel—derive their supplies from private wells sunk in the gravel. The hardness of the water varies from 30 to 60 degrees, is seldom below 30 degrees, and traces of iron are of frequent occurrence in the well and spring waters. Springs from the Middle Lias are frequently iron; the chalybeate spring at Gumley Hall was for a time held in repute for curative purposes. Wells and boreholes in the Lower Lias are liable to collect saline water.

In this Rural District it is useless to attempt to obtain water by sinking deep wells or boreholes into the Lower Lias: resort must be had to the Glacial gravel and sand. Locally, these Glacial deposits do and would yield supplies adequate for small requirements, but the water is liable to be hard. The best springs in the district are at Mowsley (p. 80).

**Arnesby**—Maps: 170; [63 S.E.]; (44 N.E., S.E.)

H. G. Coales had sunk on Mr. Freer's land on the west side of the valley between Fleckney and Arnesby, and in the latter parish, fourteen boreholes. Five were in Lower Lias clay, and nine in gravel. "The visible outflow from this gravel was 8,000 gallons a day, which *might* yield double that amount if collected by a well."<sup>1</sup>

**Fleckney**—Maps: 170; [63 S.E.]; (44 N.E., S.E., 45 N.W., S.W.)

#### ANALYSIS

Well (new, 1926) in Lower Lias, Park Street, Fleckney.

<sup>1</sup> Coales, H. G., 'Fleckney Water,' 1914, p. 3.



Date : 12th July, 1926

Appearance in 2-ft. tube ... ..	Clear	
Odour ... ..	Nil	
Reaction ... ..	Faintly alkaline	
	Parts per	Grains per
	100,000	gallon
Free and saline ammonia ... ..	0.001	0.0007
Albuminoid ammonia ... ..	0.008	0.0056
Chlorine in chlorides ... ..	2.9	2.03
(Equal to chloride of sodium)	4.7	3.2
Nitrogen in nitrates ... ..	1.86	1.3

Made by Dr. T. Roberson.

**Foxton**—Maps : 170 ; [63 S.E.] ; (45 S.E., 50 N.W., N.E.)

In the orchard south-east of the Church (at the 'h' of 'Ch.' on the 1-inch Ordnance Survey Map, Sheet 170) is a well in gravel. The water runs out of this well, through a pipe (syphon under the canal) down the main street of the village, and discharges into two wells.

**Gumley**—Maps : 170 ; [63 S.E.] ; (45 S.W., S.E., 50 N.W.)

*Gumley Hall Iron-(weak) Saline Spring.*—Near Gumley Hall is a spring which Nichols said in 1798<sup>1</sup> was very famous and was mentioned in "some very old writings." The water was first analysed by Dr. William Morris in 1789 and the account of his experiments and his observations thereon were first published by Nichols. The spring issues from the Middle Lias.

"The Gumley Hall water, from its lightness and chalybeate properties at the spring, seems to be equal, if not superior, to any of our mineral waters in Great Britain. It resembles principally the Tunbridge water."

**Husbands Bosworth**—Maps : 170 ; [53 N.E., 63 S.E.] ; (49 N.E., S.E., 50 S.W., 53 N.E., 54 N.W.)

This village is on Lower Lias clay and is dependent on wells the supplies in many of which at times greatly diminish.

**Kibworth Beauchamp**—Maps : 170 ; [63 S.E.] ; (45 N.W., S.W., S.E.)

Springs issue from the gravel on Mr. Guy Paget's land on the east side of the canal at about a mile and a half west of Kibworth Harcourt Church. H. G. Coales<sup>2</sup> estimated the visible outflow of water from the gravel-bed at 10,000 gallons a day, but was of the opinion that the gravel-bed "might yield double this amount in a collecting well, as the stream on the west side of the canal from this source amounts to 30,000 gallons a day (part, however, of this may be canal leakage)."

**Laughton**—Maps : 170 ; [63 S.E.] ; (45 S.W., 50 N.W.)

*Laughton Edge*, well at. Information from W. Keay. 1920. Ht. above O.D., about 562 ft.

		Thickness Depth	
		Ft.	Ft.
[Middle Lias]	{ Clay, yellow, shaly, rather ferruginous ...	6	6
	{ Shale, light grey ... ..	23	29
	{ Rock, hard, grey-green, calcareous sandy	—	—

Yield :—900 gallons in 24 hours. Rest-level about 24 ft. from the surface.

<sup>1</sup> 'The History and Antiquities of the County of Leicester,' vol. ii, pt. 2, 1798, p. 589.

<sup>2</sup> 'Fleckney Water,' 1914, p. 4.

**Lubenham**—Maps : 170 ; [63 S.E.] ; (50 N.W., N.E., S.W., S.E.)

A number of houses in this village are supplied from a tap connected with the Market Harborough main ; but the majority are dependent on wells.

**Mowsley**—Maps : 170 ; [63 S.E.] ; (44 S.E., 45 S.W., 49 N.E., 50 N.W.)

Mowsley village is on gravel associated with the Boulder Clay. It is dependent on wells, in one of which the water-level stood at 475 ft. O.D. The gravel appears to attain locally a thickness of about 40 feet. Springs flow out of the gravel west, north, and east of the village, and H. G. Coales estimated the visible quantity of water at "40,000 gallons a day at least."<sup>1</sup> Analyses of waters from (1) the main Mowsley Springs, and (2) a land drain (spring water) between the main springs and the village, are given below.

*Mowsley Springs*.—These springs issue from the gravel, which rests on Lower Lias, just below the hedge at the top of a field (on the valley side) that commences at about 200 yards N.N.W. of the church, at an altitude of about 443 ft. O.D. The water is slightly chalybeate. These are the largest springs in the Rural District.

#### ANALYSES

Mowsley Springs.—From Boulder Clay and associated gravel and sand—mainly gravel.

1. Main Mowsley Springs.

2. Water (spring) from land-drain (in Mr. Mawbey's field) between main Mowsley Springs and the village.

	1	2
Date ... ..	26.9.1914	26.9.1914
Appearance in 2-ft. tube ... ..	Clear and colourless	Clear and colourless
Smell when heated to 100° F. ...	Odourless	Odourless
	In grains	per gallon
Solid matter (dried at 212° F.) ...	33·600	47·600
Chlorine as chlorides ... ..	1·500	1·800
Free ammonia ... ..	0·005	0·014
Albuminoid ammonia ... ..	0·008	0·010
Nitrates ... ..	None	None
Nitrites ... ..	None	None
Metals ... ..	None	None
Hardness : Total ... ..	over 30°	over 30°

#### MICROSCOPICAL EXAMINATION

1. Showed living micro-organisms of a harmless character with some vegetable debris.

2. Showed living micro-organisms (Cyclops and specimens of the Ciliata) with a considerable quantity of vegetable matter.

#### REPORT

1. This is a very good sample of water which may be used for drinking and household purposes with safety. The solid matter consists principally of 'carbonates.'

2. This water should be passed through a filter before being used for drinking and dietetic purposes.

By A. J. Freeland, Analytical Chemist, Kibworth, Leicestershire, and communicated by Mr. H. G. Coales, Engineer and Surveyor, Market Harborough.

<sup>1</sup> 'Fleckney Water,' 1914, p. 4.

*Well* (new, 1923) in gravel (Glacial). Analysis by Dr. J. A. Fairer.

Date : 7th November, 1923.

Appearance in 2-ft. tube ... ..

Odour ... ..

Reaction ... ..

Clear

Nil

Faintly alkaline

	Parts per	Grains per
	100,000	gallon
Free and saline ammonia ... ..	0.001	0.0007
Albuminoid ammonia ... ..	0.012	0.0084
Chlorine in chlorides ... ..	4.2	2.94
(Equal to Chloride of Sodium) ... ..	6.9	4.8
Nitrogen in nitrates ... ..	1.1	0.8

**North Kilworth**—Maps : 170 ; [63 S.E.] ; (49 S.E., 53 N.E.)

North Kilworth village is for the most part on Boulder Clay with associated gravel—the gravel here predominating.

*North Kilworth Village Spring*.—About 200 yards N.N.E. of the Church, down Crammer Lane, a considerable quantity of water issues from the base of the gravel-bed from which it is thrown out by the subjacent Lower Lias clay. Some of this water runs through a pipe forming a 'spout spring' from which those living in the vicinity obtain supplies. Practically all, however, runs to waste. It is unfortunate that in a district where good springs are so few that this one has in the immediate vicinity of its outflow a churchyard and dwellings and is the resort of cattle.

*Grange Farm Boring*.—Near barn a quarter of a mile N.E. by N. of Grange Farm.

Lower Lias. Blue clay ... .. 113 ft.

"No sign of water."—H. G. Coales, Engineer and Surveyor, Market Harborough U. D. C.

**Theddingworth**—Maps : 170 ; [63 S.E.] ; (50 N.W., S.W.)

Except for one house, which has the Market Harborough water laid on, the houses in this village are dependent on wells the supplies in which at times greatly diminish.

## MELTON MOWBRAY RURAL DISTRICT

The vale around Melton Mowbray, as far east as Stapleford, and in the vicinity of Long Clawson, is floored with Lower Lias, but in the former area the 'solid' rock (Lower Lias) is mostly obscured by a thick covering of Chalky Boulder Clay. Locally, Glacial sands are associated with the Boulder Clay and on patches of such are situate the major portions of the villages of Great Dalby, Burton Lazars, Stapleford, Saxby, Freeby, Grimston, Ragdale, and Hoby. Below Melton Mowbray the River Wreak is extensively margined with river gravel (terrace) and on patches of the gravel are located the villages of Asfordby, Frisby-on-the-Wreak, Rotherby, and Brooksby. Melton Mowbray itself is almost entirely on Wreak-side Alluvium. The villages on the Boulder Clay are mostly very small and the clay tract as a whole is sparsely populated. Borings that have been made into the Lower Lias have been unsuccessful.



The high ground from Old Dalby, by way of Eastwell,<sup>1</sup> Eaton, and Branston, and then south by way of Sproxtton, Wymondham, Pickwell, and Burrow-on-the-Hill, is composed (in ascending order) of Middle Lias, Upper Lias, and patches of Northampton Sand and Lincolnshire Limestone.

The Marlstone—the upper member of the Middle Lias—is an important water-bearer containing in its many crevices and fissures much water. In this district it is from 18 to 30 ft. thick. The sites of a number of villages, for example, Pickwell, Edmondthorpe, Wymondham, Wartnaby, Ab Kettleby, Holwell, Scalford, Goadby Marwood, Eaton and Branston, have obviously had their sites determined by this aquifer; Melton Mowbray derives the bulk of its public supply therefrom in the vicinity of Scalford. Glacial deposits, however, are met with on the high ground: Somerby is on a patch of Glacial sand overlying Marlstone. Water from the Marlstone<sup>1</sup> is liable to be ferruginous.

The Upper Lias is almost entirely clay and averages about 120 ft. in thickness. It is not an aquifer, but patches of Glacial sand on its surface have provided sites for such villages as Knosington and Cold Overton.

The Northampton Beds<sup>2</sup> yield water which is, however, liable to be ferruginous: on them are situate Waltham-on-the-Wolds and Saltby. Springs issue from the junction of the Ironstone and Upper Lias, and Saltby, Croxton Kerrial, and Belvoir have piped services from such.

According to E. C. Moorhouse, Surveyor and Sanitary Inspector to the Melton Mowbray Rural District Council, the only springs in the district worthy of mention are those in Bescaby Wood and “the ironstone country.”

**Ab Kettleby**—Maps: 142; (12 S.E., 19 N.E.)

The village is on Marlstone. Just east of the Church is a spring—normally yielding 24,000 to 25,000 gallons a day—which never runs dry.

**Asfordby**—Maps: 142; (19 N.E., S.W., S.E.)

Asfordby village is mainly on river gravel and is dependent on wells the supplies in which run low at times. There are three public pumps the supply from one of which is at times deficient. In the allotments, which are on gravel, to the west of the village, is a well (fitted with a pump) that never fails.

At a site above the ‘u’ in ‘Pasture’ of Pasture House, Geological Survey Map (New Series), Sheet 142, the Stanton Iron Co., Ltd., have had a borehole made to supply some fifty houses which they have recently erected. The borehole (diameter 8 in.) is about 90 feet deep and goes through Boulder Clay into Lower Lias. The supply is said to be satisfactory.

*Holwell Ironworks (Stanton Iron Co., Ltd.).*—Boring for water, 200 yards E. of Holwell New Iron Works, Asfordby Hill. Map 19 N.E. Ht. above O.D. about 320 ft.

<sup>1</sup> Or ‘Banbury Ironstone.’

<sup>2</sup> The lower part is the ‘Northampton Ironstone’ of *scissi hemera*. See also footnote on page 1 of this memoir.

Communicated by Holwell Iron Company; published in the 'Melton Mowbray Memoir,' 1909, p. 106.

		Thickness		Depth	
		Ft.	In.	Ft.	In.
Glacial	Yellow clay, easily got ...	10	0	—	
	Yellow clay with blue cast ...	77	0	—	
	Sandy loam ...	2	0	—	
	Blue clay with very much gravel ...	8	6	97	6
	Brassy rock ...	0	1½	—	
	Blue clay—very soft shale ...	5	0	—	
	Hard white rock [Limestone band]	0	4	—	
Lower Lias	Blue shale ...	0	8	—	
	Brassy rock ...	0	1½	—	
	Blue shale—medium strength, with small fossils ...	9	3	113	0
	Blue clay—stained with ochre ...	0	3	—	
	Dark blue bind ...	3	0	—	
	Mass of fossils in white rock heavily stained with ochre [? Limestone band] ...	0	4	—	
	Blue shale ...	3	5	—	
	Blue shale—excess fossils ...	0	8	—	
	Blue shale ...	4	7	125	3

Water burst in, and rose 40 ft. in well.

Strata dip at about 1 in 24 toward east.

*Railway Station.*

'Leicester Memoir,' 1903, p. 89.

Gravel ... 5 ft.

**Bescaby**—Maps: 142, 143; [70]; (13 N.E., S.E., 14 N.W.)

The village is on Lincolnshire Limestone.

*Hamwell Spring.*—According to C. B. Wedd,<sup>1</sup> "A slight depression beginning S.W. of Bescaby increases near that place to a conspicuous valley descending in an E.N.E. direction. In it a strong spring (Hamwell Spring) issues from the limestone and is regarded as the source of the River Eye. The existence of the spring, and probably of the valley itself, at Bescaby is attributable to the presence of a band of grey clay, some 2 ft. of which is seen here and there in the valley bottom. But for the slightly synclinal structure of the tract, the clay might be regarded as belonging to the Estuarine Series, below the limestone it is, however, more probably equivalent to the clay band seen near the base of the limestone in the Waltham quarry."

**Branston**—Maps: 142; (7 N.E., S.E., 13 N.E.)

Branston village is situate on the Marlstone and derives its supply from private wells sunk therein.

**Buckminster**—Maps: 143; [70]; (14 S.W., S.E., 21 N.W., N.E.)

This village, which is on the Northampton Beds, has a piped supply (completed 1912), belonging to the Earl of Dysart. The source of supply is a well on the east side of the road a quarter of a mile N.N.W. from Sewstern Church. The water is pumped to a water-tower in Buckminster village.

<sup>1</sup> 'Melton Mowbray Memoir,' p. 61.

Well (diameter, 12 ft.) :—					Thickness Ft.	Depth Ft.
	Soil and drift	...	...	...	3	3
Inf. Oolite	Northampton Ironstone	...	...	...	16	19
Upper Lias	{ Grey argillaceous sand, indurated ; fossiliferous (see below)			...	1	20
	{ Clay, blue			...	1	21

Yield.—20,000 gallons have been pumped in ten consecutive hours. Average daily quantity of water pumped : (summer)—1,785 gallons ; (winter)—3,214 gallons.

The fossils from the grey sand have been examined by S. S. Buckman. A belemnite is a *Dactyloteuthis* near to *irregularis* which Phillips figures as from the 'Sands'—may mean Cephalopod Bed—of Frocester Hill, Gloucestershire. The terebratulæ are probably examples of *Lobothyris* near to *L. haresfieldensis*, and a rhynchonellid may be a dwarf form allied to *Homærhynchia cynoprosofa* S. Buckman. The specimens may indicate a deposit of *hemera dumortieræ* (S. S. Buckman, *in. litt.* 20.8.1928).

*Buckminster Aerodrome*.—The site of the boring here—close to the east side of the road half-a-mile due W. of Tithe Farm—is just within the Lincolnshire parish of Colsterworth. 1918. Ht. above O.D., 454.3 ft.

					Thickness Ft.	Depth Ft.
Top soil ... ..					1	1
Northampton Beds	{ Ironstone ... ..				13	14
	{ Sand and clay ... ..				2	16
	{ Blue clay ... ..				24	40
	{ Clay stones ... ..				0½	40½
	{ Blue clay ... ..				25½	66½
Upper Lias	{ Clay stones ... ..				0¾	67
	{ Blue clay ... ..				63	130
	{ Iron pyrites ... ..				0½	130½
	{ Blue clay ... ..				25¾	156
	{ Blue clay and ammonites ... ..				41	197
	{ Blue Stone. " Fossil Bed " ... ..				3	200
	{ Blue clay ... ..				14	214
	{ Blue paper shale ... ..				9	223
	{ Limestone and shale beds ... ..				14½	237½
	{ Blue clay and limestone beds ... ..				1	238½
Middle Lias	{ Limestone bed and fossils* ... ..				11	249½
	{ Clay and stone ... ..				0½	250
	{ Sandy and micaceous clay ... ..				0½	250½

\*Fissures struck at 246½ ft. and at 248½ ft.

Diameter of boring 6 in. Water-level 135 ft. down. Yield (fide R. Richards) 2,000 gallons an hour : saline.

Boring made by Messrs. R. Richards & Co. and information from the Air Ministry.

### Burrow-on-the-Hill—Maps : 156 ; (27 S.W., 33 N.W.)

*Burrow Court*, well at. Sunk by H. Herbert & Sons, Builders ; information from S. Herbert per W. Keay. December, 1917.

Well (115 ft.) and borehole (20 ft.) :—

[Glacial]	Boulder Clay	} 135 ft.
[? M. Lias]	Limestone	

Result.—No water ; have to use rainwater.



Robert Moss, of Loughborough, on 24th August, 1925, informed Mr. Keay that another boring had been made on the north side of the road (opposite the Court), 150 ft. deep, on Swain's (the water diviner) advice, but was all in clay and there was no water.

**Burton Lazars**—Maps : 142, 156 ; (20 N.W., S.W., S.E., 27 N.W., N.E.)

This village is on Glacial gravel and sand. Several springs issue from the gravel and sand ; one runs into a trough ' Stockwell '—and all the village uses it.

*Burton Lazars Medicinal Spring.*—West of the village of Burton Lazars is high ground composed of Boulder Clay resting on Glacial sand and gravel and this latter deposit on Lower Lias. From this ground emerged a spring impregnated with sodium chloride and sulphuretted hydrogen. Roger de Mowbray founded a leper or lazar hospital near it in 1135. A bath was made and during the existence of the hospital was held in high repute, but gradually fell into disuse.<sup>1</sup> In 1760 the spring was sought for and found, a bath-room was built, and many cures are said to have been effected.<sup>2</sup> "... during the disorders of the murrain among the larger cattle ... the lands in Burton, ... where the ... spring rises, were a happy asylum against the ravages of the murrain : the occupants, at such times, taking in distempered cattle, where they found a certain cure. ..."<sup>3</sup> The bath-room was taken down in 1849 and the spring arched over and covered with soil.<sup>4</sup>

*Holy Well.*—By the east side of the road immediately south of Burton Lazars village is a neglected brick-sided pond described as a Holy Well on the 6-inch map. Into it discharges a small spring that issues at the junction of Glacial gravel with Lower Lias clay.

**Cold Overton**—Maps : 156 ; (27 S.E., 33 N.E.)

*Cold Overton Hall.* Boring made by, and information from, Messrs. Le Grand, Sutcliff & Gell, Ltd. 1904. Ht. above O.D., 630 ft.

						Thickness	Depth
						Ft.	Ft.
[Glacial Deposits]	{	Mould ... ..	...	...	...	1	1
		Mould and large stones	...	...	...	1	2
		Loamy sand and bands of clay	...	...	...	9	11
		Blue sandy clay (1)	...	...	...	21	32
[Upper Lias]	{	Blue clay, very hard and dry.	Band	...	...	68	100
		with fossils at 94 ft.	...	...	...	24	124
		Blue clay	...	...	...	1½	125½
		Blue clay in bands and broken rock and fossils (2)	...	...	...	8½	134
		Blue clay	...	...	...	5	139
[Middle Lias, Marlstone and 'Sandy Beds']	{	Bands, hard and soft rock and clay	...	...	...	10	149
		Rotten mixed coloured clay and bands of hard rock (3)	...	...	...	1½	150½
		Brown sand-rock and shells (4) (water)	...	...	...	5½	156
		Brown loamy ground and broken rock	...	...	...	24	180
		Blue sandy clay (more water at 163 ft.)	...	...	...	20	200
Deepened 1914						20	200

<sup>1</sup> Nichols, J., 'The History and Antiquities of the County of Leicester,' vol. ii, pt. 1 (1795), p. 269.

<sup>2</sup> Throsby, 'Excursions,' 1761, p. 178.

<sup>3</sup> *Gentleman's Magazine*, 1866, pt. 2, p. 499.

<sup>4</sup> White, W., 'History ... of Leicester and Rutland, ...' 2nd ed., 1863, p. 344.

Diameter of borehole  $7\frac{1}{4}$  in.

Tubing : 10 ft. of  $7\frac{1}{4}$  in. top  $5\frac{1}{4}$  ft. below surface.

145 ft. of 5-in.	"	$4\frac{1}{2}$ ft.	"	
31 ft. of 4-in.	"	149 ft.	"	(perforated).
20 ft. of 3-in.	"	179 ft.	"	

Yield, 540 galls. an hour (lowers water level  $2\frac{1}{2}$  ft.).

Water-levels :	Sept., 1904	...	...	...	141 ft. down.
	Jan., 1905	...	...	...	145 ft. "
	March, 1910	...	...	...	140 ft. "
	Feb., 1914	...	...	...	147 ft. "
	Dec., 1918	...	...	...	147 ft. "

1. The specimens suggest some churning up by ice of the upper part of the Upper Lias and it is difficult to say exactly where the true rock *in situ* begins.

2. Contains an ammonite, *Harpoceras mulgravium* ? (Y and B.) indicative of *hemera falciferi*.

3. Part of the hard rock is the ferruginous calcareous rock that often becomes a workable ironstone. Top of Middle Lias.

4. This contains *Terebratula radstockensis* of the Valdani Zone in the Lower Lias and suggests that the three last beds may be Lower Lias.

*Cold Overton Hall*, boring 100 yards east of. Made by, and information from, J. T. Barnes, Eastgate, Sleaford. 1914.

				Thickness	Depth
				Ft.	Ft.
[Presumably Upper Lias]	Clay	...	...	185	185
[Presumably Middle Lias]	Sandstone	...	...	55	240
	Clay	...	...	14	254

Water struck at from 220 to 240 ft. Good supply.

**Coston**—Maps : 143 ; [70] ; (14 S.W., 21 N.W.)

A spring issuing from at or near the base of the Marlstone by the side of Grange Lane (at some 350 yards S.E. by S. of the Church) is piped to the rectory and the overflow to a standpipe by the side of the lane south-east of the bridge from which the majority of those living in the village draw their drinking water.

**Eastwell**—Maps : 142 ; (7 S.W., S.E., 13 N.W., N.E.)

This village is very well off for water. Springs emerging in Boulder Clay ground, but probably originating in the Marlstone, and known as 'The Town Wells,' are used for the supply of the Hall (electric pump) and upper and lower parts of the village (two rams).

"At the east end of Eastwell the village well is said to have proved over 90 ft. of boulder clay" ('S.W. Lincolnshire Memoir,' 1885, p. 79 ; 'Melton Mowbray Memoir,' 1909, p. 72).

**Eaton**—Maps : 142 ; (7 S.W., S.E., 13 N.E.)

This village is situate almost entirely on the Marlstone and is supplied by springs therefrom and wells therein.

**Edmondthorpe**—Maps : 143 ; [64] ; (21 S.W., S.E.)

This village is represented on the Geological Survey Map, Old Series, Sheet 64, as situated on Marlstone. According to information obtained locally the "upper" (eastern) part of the village is mainly on clay and the "lower" (western) part, in which the supplies are better, on 'the rock' (Marlstone). The supplies are not very satisfactory : there are two village pumps over wells that run low in dry weather—the one (which is not much used) is near the

School; the other, from which the bulk of the drinking water is obtained, near the lodge to the Hall. This latter well would appear—from the map—to be in the Middle Lias clays and sands.

Woodwell Head Spring is a good spring from which water is raised by a ram to supply the Hall and farm.

**Garthorpe**—Maps: 142, 143; [70]; (13 S.E., 14 S.W., 20 N.E., 21 N.W.)

The village is dependent for drinking water on private wells fitted with pumps, but at the farm in the village water for other than drinking purposes and for the farm buildings is obtained from the brook from which it is pumped by a ram.

*Garthorpe Lodge.* 1911. Information from T. J. Barnes. Ht. above O.D., 390 ft.

						Thickness	Depth
						Ft.	Ft.
[Boulder Clay]	Clay and boulders ... ..					50	50
	{ Clay ... ..					140	190
[Lower Lias]	{ Sand and clay ... ..					15	205
	{ Clay ... ..					9	214
	{ Sand ... ..					7	221
	{ Clay ... ..					2	223

Water rises 136 ft. from surface. It is full of sand and small bits of coal. A sample of the water, which may have been in the bottle a long time, had a nasty smell—not of sulphuretted hydrogen.

**Goadby Marwood**—Maps: 142; (13 N.W., N.E.)

The village is on Marlstone and derives its supply from five or six arched-over dip wells.

**Great Dalby**—Maps: 142, 156; (20 S.W., 26 N.E., 27 N.W., S.W.)

This village owes its site to a bed of sand in the Boulder Clay. The well, fitted with a pump, on the village green never seems to fail; springs issue from the sand bed in the ground alongside the road between the green and the brook; and a well, fitted with a windpump, on Crown Hill obviously taps water in the same deposit.

*Police House, well at.* Sunk June, 1926.

						Thickness	Depth
						Ft.	Ft.
Boulder Clay	{ Soil and bluish clay ... ..					2	2
	{ Reddish boulder clay and stones ... ..					10	12
	{ Bluish clay with chalk and flints ... ..					7½	19½
	{ Bluish clayey gravel ... ..					2	21½
	{ Blue boulder clay ... ..					2	23½
? Lower Lias	{ Bluish shale ... ..					1½	25

Fifteen buckets of water are taken out every morning.

**Grimston**—Maps: 142; (12 S.W., S.E., 19 N.W., N.E.)

This village is on Glacial sand. The village pump—a Boulton Water Elevator—raises water from a well about 40 ft. deep.

**Hoby**—Maps: 142; (19 N.W., S.W.)

The village spreads over Boulder Clay and associated Glacial sand that rest on Lower Lias. It is dependent on dug wells and a dip well (in gravel ground) situate some 300 yards south-south-eastward from the Church.



According to Mr. Shelton, well sinker ('Leicester Memoir,' p. 90), the wells in the village reveal

"Soil and loamy mixture, 4 feet.

Sand and sharp gravel, 9 feet or more.

Blue stone, solid [Lower Lias].

Yellow clay [Lower Lias].

Some wells in clay and gravel. In red clay at Hill House."

**Holwell**—Maps : 142 ; (12 S.E., 13 N.W., S.W.)

Marlstone floors a considerable portion of this parish and has been extensively worked for iron ore. All along this tract fair quantities of water may be obtained, for small requirements, by means of wells sunk in the Marlstone, the water being held up in the rock by the subjacent, here argillaceous, 'Sandy Beds.'

*Holwell Mouth*.—About a mile W.N.W. of Holwell there is a deep comb in the escarpment. In this comb issues a small spring, slightly chalybeate, apparently from one of the hard beds in the 'Sandy Beds.' It is one of the sources, if it is not the actual source, of the River Smite which drains the Vale of Belvoir and flows northwards into the River Devon.

**Kirby Bellars**—Maps : 142, 156 ; (19 S.E., 20 S.W., 26 N.E., 27 N.W.)

*The Hall*.

'Leicester Memoir,' p. 89.

[Boulder Clay and loam—Glacial]	Clay	...	...	...	...	27 ft.
	Sand.					

*Pick's Lodge*, about half-a-mile west of Great Dalby Station. Information from W. Keay. 1917.

		Thickness Ft.	Depth Ft.
Well (121 ft. deep, 8 ft. 6 in. diameter) and borehole (44 ft. deep, 3 in. diameter) :—			
Glacial	{ Dark grey clay with fragments of limestone and chalk. At the base a deposit of fine grey sand, 6 in. thick was encountered. A heading 40 ft. long by 4 ft. by 5 ft. (in places 11 ft. high) proved this lenticle of sand to be locally 6 ft. thick ... ..	73	73
	{		
Lower Lias	{ Dark grey shaly clays with occasional lumps of limestone ... ..	52	125
	{ Shales ... ..	40	165

Rest-level on 13th March, 1918, 78 ft. down. Yield said to be 360 gallons a day, but probably much less. A water diviner, on whose advice the well was sunk, prophesied a yield of 3,000 gallons a day.

**Knossington**—Maps : 156 ; (27 S.E., 33 N.E., S.E.)

The village is on Glacial sands which rest on Upper Lias. It is dependent on wells, the supplies in which do not run low. The village well is in the sand.

**Long Clawson**—Maps : 142 ; (6 S.E., 12 N.E., S.E., 13 N.W.)

Long Clawson village is on the Lower Lias. The supplies in the wells under the three public pumps fail in dry weather.

**Nether Broughton**—Maps : 142 ; (12 N.E., S.W., S.E.)

Nether Broughton is on the Lower Lias. Messrs. Thompson & Sons had a boring made 200 ft. deep at their cheese factory but it was unsuccessful.

**Old Dalby**—Maps : 142 ; (12 S.W., S.E., 19 N.W.)

The village is on the Lower Lias. "There is no water in the village but plenty comes out of the hill"—from the Middle Lias. A spring, which has never been known to fail, issues from the Middle Lias at a locality best described as under the first 'o' in 'Wood' of Old Dalby Wood on the one-inch map 142. Water from a spring issuing from the same geological horizon to the east of the northern end of the tunnel is piped to supply the Hall, Old Dalby.

**Pickwell with Leesthorpe**—Maps : 156 ; (27 N.E., S.W., S.E.)

Borings made for Mr. Muntz of Lower Leesthorpe through Boulder Clay resting on Lower Lias in ground between Whissendine Lodge and Browne's Lodge, Whissendine parish. Borings made by, and information from, Messrs. Le Grand, Sutcliff & Gell, Ltd. 1901.

Map 27 N.E. Ht. above O.D., about 430 ft.

				Thickness	Depth
				Ft.	Ft.
No. 1.				1	—
[Boulder Clay]	{	Top soil ... ..	...	49	50
		Mottled clay and stones ... ..	...		

				Thickness	Depth
				Ft.	Ft.
No. 2.				1	1
[Boulder Clay]	{	Brown clay and stones ... ..	...	14	15
		Mottled clay and stones ... ..	...		
[Lower Lias]	{	Blue clay ... ..	...	77½	92½

Moisture at 25 ft. down.

				Thickness	Depth
				Ft.	Ft.
No. 3.				0¾	0¾
[Boulder Clay]	{	Top soil ... ..	...	2	2¾
		Brown clay and stone ... ..	...	11¼	14
		Mottled clay and stone ... ..	...	31	45
[Lower Lias]	{	Blue clay and stone ... ..	...	5	50
		Blue sandy clay and fossils ... ..	...	20	70

Moisture at 22 ft.

No supplies : all abandoned.

**Ragdale**—Maps : 142 ; (19 N.W., S.W.)

*Six Hills.* Boring (diameter, 5 in.) finished 20th May, 1904. Boring made by, and information from, Messrs. Le Grand, Sutcliff & Gell, Ltd. Ht. above O.D., 440 ft.

					Thickness	Depth
					Ft.	Ft.
Dug well					100	100
Boring :—						
[? Boulder Clay ; Lower Lias]	{	Blue marl and stone	...	...	73	173
		Brown clay	...	...	2	175
		Brown marl	...	...	7	182
		Brown clay	...	...	2	184
		Brown clay and stones	...	...	15½	199½
		Blue clay and stones	...	...	3	202½
		Blue clay	...	...	1¼	203¾

Tubing (5-inch) withdrawn. Water-level (standing), 84 ft. down.

*The Durham Ox*<sup>1</sup>, *Six Hills*. Communicated (14.10.1927) by F. Tabberer per W. Keay.

*Well No. 1.*—In orchard, 60 ft. deep, filled with surface water which on analysis was found to be unfit for drinking. Water pumped out and well is now dry.

*Well No. 2.*—Near house, 55 ft. deep, contains 5 ft. 6 in. of water believed to have "risen from the bottom." A water diviner (Rowlatt) was employed on the well. The water is not used, as the Brewery Company send water for drinking purposes from Leicester.

Both wells are in Boulder Clay.

**Saltby**—Maps : 143 ; [70] ; (14 N.W., N.E., S.W.)

The upper part of Saltby village is on Lincolnshire Limestone ; the part that extends down the slope—according to the Geological Survey map—on Boulder Clay which obscures the outcrops of Northampton Beds and Upper Lias. There are wells fitted with pumps in the village and the water in many in the upper part is good but hard ; but there is also a piped service belonging to Belvoir Estates, Ltd. The water for this undertaking is obtained from a spring from the Northampton Beds situate  $\frac{3}{4}$  mile W. by 10°S. from Saltby Church, and is raised by a windpump (with a ram for a standby in times of wind-failure) to reservoirs from which it gravitates to standpipes.

**Saxby**—Maps : 142 ; (13 S.E., 20 N.E., S.E., 21 N.W.)

'*Saxby Boring*,' about 560 yards S. 10°E. of Saxby Church. Map 20 N.E. Ht. above O.D., about 290 ft.

'*Leicester Memoir*,' p. 94 ; '*Melton Mowbray Memoir*,' p. 107.

					Thickness	Depth
					Ft.	Ft.
Lower Lias	{	Soil and blue clay	...	...	14	14
		Nodular limestone rock	...	...	2 $\frac{1}{2}$	16 $\frac{1}{2}$
		Blue clay	...	...	31	47 $\frac{1}{2}$
		Rock	...	...	2	49 $\frac{1}{2}$
		Blue clay	...	...	76	125 $\frac{1}{2}$
		Rock (small supply of water from this rock)	...	...	7 $\frac{1}{2}$	133
		Clay	...	...	92	225
		Rock (water found here)	...	...	4 $\frac{1}{2}$	229 $\frac{1}{2}$
		Clay and soft rock	...	...	2	231 $\frac{1}{2}$
		Rock	...	...	8 $\frac{1}{2}$	240
		Clay	...	...	36 $\frac{1}{2}$	276 $\frac{1}{2}$
		Rock (a little more water found in this rock)	...	...	5	281 $\frac{1}{2}$
		Clay	...	...	16 $\frac{1}{2}$	298
		Rock	...	...	4	302
		Clay	...	...	7 $\frac{1}{2}$	309 $\frac{1}{2}$

Communicated in 1891 by the Trustees of the late Earl of Dysart. C. B. Wedd says ('*Melton Mowbray Memoir*,' p. 39) :—" In view of the thickness of the higher zones [of the Lower Lias] in this district and the character of the strata penetrated, it is doubtful whether the bore-hole reached the *Gryphæa*-limestone of the *Bucklandi* Zone."

**Scalford**—Maps : 142 ; (13 N.W., S.W., S.E., 20 N.W.)

The village is on the Marlstone. It is dependent on wells and a good open spring. The Parish Council has first call on this spring from which the overflow runs into the Melton Mowbray Urban District Council's supply.

<sup>1</sup> In the parish of Willoughby-on-the-Wolds, Nottinghamshire, just outside the Leicester county boundary.



*Police Station*, old well at. Well 22 ft. deep with 2 ft. of water (March 10th, 1921) which could not be lowered to bottom by buckets. In the Marlstone. Approximate inflow 60 gallons per hour. Very good water.

*Shafts and Borings at the Melton Mowbray Water Works*. Map 13 N.W. Reproduced from the 'Melton Mowbray Memoir,' p. 107. Communicated by Baldwin Latham, M.I.C.E.

Numerous shallow shafts were sunk at distances from  $\frac{1}{2}$  mile to 1 mile N. of Scalford. These shafts are situated, some above, some just below the base of the Marlstone. As they traverse approximately the same strata, the following will suffice as illustrations:—

Section at Ram-chamber A; 920 yards N. 14° E. of Scalford Church.

Height above O.D. 393·83 ft.

							Depth	
							Ft.	In.
Middle Lias	Marlstone	Surface soil	...	...	...	...	1	0
		Loam	...	...	...	[to]	4	0
		Soft sandstone with little iron and clay	...	...	...	[to]	4	9
		Soft sandstone in thin layers	...	...	...	[to]	7	0
		Nodules of grey limestone with some iron	...	...	...	[at]	14	6
		Soft sandstone in thin layers	...	...	...	[to]	15	6
		(Water met with at	...	...	...	...	21	0)
		Soft sandstone with some hard lumps of ironstone and a little clay	...	...	...	[to]	22	0
		Grey marl	...	...	...	..	23	0

Section at Shaft E; 1,550 yards N. 18° E. of Scalford Church.

Height above O.D., 402·6 ft.

Middle Lias	Surface soil	...	...	...	...	...	2	0
	Loam	...	...	...	...	[to]	5	0
	Clay	...	...	...	...	..	6	6
	Sandy shale	...	...	...	...	..	11	6
	Blue marl	...	...	...	...	..	15	10

*The Lion Brick and Tile Works*, one mile N.N.W. of Scalford.

'Melton Mowbray Memoir,' pp. 43, 44.

Wells:—

- (1) in N.W. corner of large pit—  
75 ft. clay with  $1\frac{1}{2}$  ft. bed of limestone in upper part.
- (2) at S. end of works (where the surface is apparently just below the base of the Marlstone)—  
35 ft. clay with a thin bed of limestone 15 ft. from top.

**Sewstern**—Maps: 143; [70]; (14 S.E., 21 N.W., N.E.)

The village is on the Northampton Beds and is dependent on wells fitted with pumps.

**Somerby**—Maps: 156; (27 S.W., S.E., 33 N.W., N.E.)

The greater part of the village is on Glacial sand overlying Marlstone; the smaller part on Marlstone. Supplies for some of the larger houses are pumped by windpumps from considerable distances.

**Sproxtton**—Maps: 143; [70]; (14 N.W., N.E., S.W., S.E.)

The lower and main part of Sproxtton village is on the Marlstone. Part has a piped service (to standpipes) and part is dependent on wells fitted with pumps. The piped supply is obtained from a spring issuing from the Marlstone in the valley west of the River Eye about a mile west of Sproxtton. The

spring is collected and piped to a sump by the river and thence to a pumping-station on the left bank south of but close to the bridge that carries the road from Sproxton to Stonesby. The power for the pump is derived from a water-wheel worked by the river, but in dry times the water in the river is scarcely sufficient for the purpose. The water is hard and somewhat irony. When an insufficient quantity of water is pumped for the reason stated a pump in the yard opposite the village Post Office is made much use of.

The ram north of the bridge over the Eye pumps river-water to the ironstone workings.

### Stapleford—Maps : 142 ; 156 ; (20 S.E., 27 N.E.)

#### *Stapleford Park.*—

“ Prof. Judd mentions that a deep well sunk in Stapleford Park reached blue clays with numerous *Gryphea arcuata* and arietite ammonites, which he seems to have regarded as belonging to the *Bucklandi* Zone.<sup>1</sup> He does not further specify its position, but it may be the well 600 yds. S.E. of the Hall, as we were informed that this was more than 100 ft. deep.”<sup>2</sup>

### Stathern—Maps : 142 ; (7 N.W., N.E., S.W., S.E.)

Part of the village is supplied by an undertaking belonging to the Stathern Parish Council from springs (? from the upper part of the Lower Lias) in a field on the south-west side of a wood at Toft's Hill, Stathern. The water is piped to a reservoir (12,000 gallons) in a field near the Red Lion Inn whence it gravitates to three standposts fitted with taps.

‘*Dalliwell Pump*’ is near the Church and over a well catching water presumably from Glacial sands. The supply has never been known to fail and maintains its yield when the Parish Council's supply has run low in dry weather.

*Harby and Stathern Station*, 20 yards due E. of the southern end of the platform. Boring made by, and information from, Messrs. Le Grand, Sutcliffe & Gell, Ltd. Boring finished 1st November, 1916. Ht. above O.D., 200 ft.

		Thickness		Depth	
		Ft.		Ft.	
Dug well (in Lower Lias : diameter 3½ ft.) ...		26		26	
Boring (diameter 2¾ in.) :—					
[Lower Lias]	Clay ... ..	30		56	
	Clay and shale ... ..	10		66	
	Clay and conglomerate ... ..	4½		70½	
	Clay and shale ... ..	10		80½	
	Clay ... ..	10½		91	
	Clay, shale and mundic ... ..	15		106	
	Clay and layers of shaly clay and shells ...	16		122	
	Stone ... ..	3		125	
	Shale and clay-stone ... ..	12		137	
	Clay and shale ... ..	1½		138½	
	Shaly clay and bands of limestone ...	9½		148½	
	Hard clay ... ..	8½		157	
	Stone ... ..	1		158	
	Dark grey clay and bands of limestone ...	2		160	
	Blue clay and shell conglomerate ...	2		162	
	Dark blue clay ... ..	29¼		191¼	
	Hard shaly clay ... ..	7¾		199	
	Clay and bands of shale ... ..	19		218	

<sup>1</sup> ‘*Geology of Rutland*’ (*Mem. Geol. Surv.*), 1875, p. 60.

<sup>2</sup> ‘*Melton Mowbray Memoir*,’ p. 38.

Hole quite dry throughout although in a borehole and also a well within 50 yards soakage from the shale was found, but the yield when tested from the dug well was less than 10 gallons an hour, lowering the water-level from 8 to 26 feet down.

**Stonesby**—Maps : 142, 143 ; [70] ; (13 S.E., 14 S.W.)

The village is mostly on Lincolnshire Limestone and is dependent on wells. A spring, which is always running and is not used, flows across the road.

**Sysonby**—Maps : 142 ; (19 N.E., S.E., 20 N.W., S.W.)

*Sysonby House.*

'Melton Mowbray Memoir,' p. 66.

Well :—

Boulder Clay proved to exceed 168 ft.

**Thorpe Arnold**—Maps : 142 ; (13 S.W., S.E., 20 N.W., N.E., S.W.)

The little village is on Boulder Clay overlying Glacial sand that rests on Lower Lias. A well sunk a little to the south-west of the Church (under the 'Ch.' on the 1-inch geological map, Sheet 142) 80 to 90 ft. deep tapped a good supply of water.

**Thorpe Satchville**—Maps : 156 ; (26 N.E., S.E., 27 N.W., S.W.)

*Messrs. Cowdell & Bryan*, well at.  $\frac{1}{2}$  mile N.N.E. of Church. 1920. Ht. above O.D., 500 ft. Information from W. Keay.

						Thickness	Depth
						Ft.	Ft.
[Boulder Clay]	{	Blue boulder clay ...	...	...	...	35	35
		Thin veins of sand	...	...	...	—	—
		Blue clay ...	...	...	...	7	42
		Red clay ...	...	...	...	3	45
		Gravel ...	...	...	...	1	46

Estimated supply about 1,000 gallons per day of good water.

*Hall*. Boring by, and information from, Messrs. Le Grand, Sutcliffe & Gell, Ltd. 1922. Ht. above O.D., about 475 ft.

						Thickness	Depth
						Ft. In.	Ft. In.
Existing well	{	Medium brown sand and a few	...	...	...	60 6	60 6
		small stones	...	...	...	1 0	—
[Glacial]	{	Sand with stones	...	...	...	2 6	64 0
[? Lower Lias]	{	Blue clay and stones	...	...	...	3 9	67 9

Water-level about  $5\frac{1}{2}$  ft. down. Hole abandoned, no supply.

**Twyford**—Maps : 156 ; (26 S.E., 27 S.W., 32 N.E., 33 N.W.)

The Church and houses near are on river gravel : the remainder of the village is partly on Boulder Clay and partly on Lower Lias. According to E. C. Moorhouse the pump by the road-side south of the Church is over a well about 60 feet deep which yields a good supply.

According to J. A. L. Beasley "Twyford is singularly placed as to water. A small area near the Church, where gravel crops out, is well supplied with spring water of an excellent quality—in fact, strange to say, not so hard as spring water usually is found [in these parts]. Further the churchyard being located over this area the wonder is no pollution occurs."



**Waltham-on-the-Wolds**—Maps : 142 ; (13 N.E., S.W., S.E.)

This village is on Northampton Beds except for a small portion which is on Upper Lias clay that comes to the surface along the east side of a fault. It is dependent on wells, the supplies in which never run low.

*Royal Horse Shoe Inn*.—In the yard of the inn a well " . . . was dug and bored to a depth of 40 yards in blue [Upper Lias] clay without finding water ; while at a cottage west of the yard water was found in [Northamptonshire] ironstone at a depth of 14 ft. Here, therefore, the ironstone is faulted against Upper Lias."<sup>1</sup>

**Wycomb and Chadwell**—Maps : 142 ; (13 N.W., N.E., S.W., S.E.)

The bulk of the water used at Chadwell is obtained from a dip well (in Boulder Clay ground) situate some 300 yards E. by S. of the Church. There is another spring about the same distance to the S. by E. from the Church.

**Wymondham**—Maps : 142, 143 ; [64] ; (20 S.E., 21 N.W., N.E., S.W., S.E.)

The village is situate on ' the rock ' (Marlstone) and is dependent on private wells, the majority of which are fitted with pumps.

## LOUGHBOROUGH RURAL DISTRICT

The ' solid ' rock on which this district is situate is the Upper Keuper Marl with the exception of (1) the portion of the Charnwood Forest area which comes within it in which Pre-Cambrian rocks project through the mantle of Marl and in the vicinity of which Lower Keuper Sandstone emerges locally from beneath the Marl ; and (2) the neighbourhood of Wymeswold which has, beneath the Glacial deposits, Lower Lias. Chalky Boulder Clay, part of a thick sheet, spreads over the ' solid ' rocks in the vicinity of Wymeswold and detached spreads occur in other parts of the district. In the vicinity of the River Soar are terraces of river-gravels ; while the flat ground margining the river and extending for various distances up the valleys of its tributaries is composed of Alluvium.

The villages of Belton, Burton-on-the-Wold, Long Whatton, and Prestwold are mainly on Keuper Marl ; Hoton on Boulder Clay ; Wymeswold on sand and gravel associated with the Boulder Clay ; Cotes, Hathern, Thorpe Acre, Dishley, and Woodthorpe on river-gravels ; and Garendon on Alluvium.

The Wood Brook, with a gathering ground of 1,050 acres (Nanpanton), and Blackbrook, with a gathering ground of 2,867 acres (two miles south-westward of Shepshed), maintained by water draining off the Pre-Cambrian rocks of Charnwood Forest and mantling Triassic rocks are impounded for the supply of Loughborough.

Concerning the rocks that underlie the Keuper Marl the only boring in the district that furnishes information is that near Hathern village ; but reference should be made to the records of those near

<sup>1</sup> ' Geology of S.W. part of Lincolnshire, etc.' (*Mem. Geol. Surv.*), 1885, p. 50.

Piper Wood, Shepshed, and near Hathern Station in Sutton Bonnington parish, Nottinghamshire (pp. 125 and 96).

The villages of Nanpanton and Thorpe Acre, Prestwold Hall (not the village), and Burleigh Hall have the public supply from the Borough of Loughborough. In other parts of the district the water is derived from wells the majority of which are in the Superficial Deposits.

G. Morgan, Sanitary Inspector to the Council, informs me that the only spring worthy of mention of which he knows is at Burton Hall Park, Burton-on-the-Wolds.

**Burton-on-the-Wolds**—Maps: 142; (11 S.E., 12 S.W., 18 N.W., N.E., 19 N.W.)

The village of Burton-on-the-Wolds is supplied by a perennial spring which issues from sand and gravel (Superficial Deposits—Glacial) on rising ground at Burton Hall Park. The water discharges through an iron pipe in Vicarage Street.

**Hathern**—Maps: 141; (10 S.W., S.E., 17 N.W., N.E.)

*Hathern Boring*: 1864-65. Diamond boring south-east of village on east side of road almost opposite the entrance to the drive to Garendon Hall. Ht. above O.D., about 130 ft. Record in *Rep. Brit. Assoc.*, 1875, p. 137.

	Thickness		Depth	
	Ft.		Ft.	
Drift ... ..	10		10	
Red marl ... ..	110		120	
Lower Keuper Sandstone ... ..	140		260	
Bunter Conglomerate ... ..	60 ?		320	

The boring was carried down to 472 ft. but there is no record of the strata between 320 and 473 ft. 9½ in.

Between February 3rd and May 19th, 1876, this boring was continued to a depth of 879 ft. The following record from James Plant's MSS. was published in the 'Coalfield Memoir,' p. 358, and 'Loughborough Memoir' p. 54.

	Thickness		Depth	
	Ft.	In.	Ft.	In.
[Older boring, details given above] ... ..	320	0	320	0
[No record of these strata] ... ..	153	9½	473	9½
Broken ground. Supposed Bunter with pebbles ... ..	3	10	477	7½
Bunter ... ..	14	10	492	5½
Conglomerate ... ..	8	6	—	—
[Beds not described] ... ..	12	7	—	—
Conglomerate ... ..	2	10	516	4½
Blue clay with bright red lamination ... ..	2	0	—	—
Dark shale with pyrites ... ..	16	1½	—	—
Dark shale... ..	39	7	—	—
Dark shale, some harder ... ..	7	11	—	—
Dark shale... ..	20	7½	—	—
Dark shale, with hard bands ... ..	7	6	—	—
Dark shale... ..	136	3½	—	—
Dark shale, very hard, with white veins ... ..	16	0	—	—
Dark shale... ..	8	3	—	—
Dark shale and dark and light hard rock ... ..	3	6	774	1½

	Thickness		Depth	
	Ft.	In.	Ft.	In.
Hard rock ... ..	4	4	778	5 $\frac{3}{4}$
Hard light rock or magnesian limestone ...	1	9	780	2 $\frac{3}{4}$
Dark shale and hard rock ... ..	20	3	—	—
Dark shale 7 ft. 7 in. with a little blue clay 2 in. ...	8	0	—	—
Dark shale and hard rock ... ..	14	5	—	—
Dark shale (lost core) ... ..	9	3	—	—
Dark shale... ..	17	9	849	10 $\frac{3}{4}$
Limestone shales ... ..	14	0	—	—
Limestone shales, with a little black shale alternating ... ..	15	0	878	10 $\frac{3}{4}$

At p. 106 of the 'Coalfield Memoir,' Fox-Strangways says that the dark shales entered at 516 ft. 4 $\frac{1}{4}$  in. have been supposed to be of Carboniferous age, "but from the evidence afforded by later borings were more probably of Silurian age or older." Three specimens of the cores from the 1876 boring are in the Geological Survey Collection. They are sandy limestones, with shales, from about 820 to 840 feet, which suggest that the bottom of the boring is not far above the massive limestone and that the dark shales are 'Upper Limestone Shales' of lower Millstone Grit age. (See p. 99). In a 'Report on Temporary Supply of Water for Leicester,' January 13th, 1903 (typescript) Fox-Strangways says: "Water is stated to have been 'most abundant,' and rose 40 to 50 feet above the surface."

William Keay, M.Inst.C.E., informs me that he visited the borehole on January 9th, 1903. The borehole was not visible but water was apparently overflowing at the rate of about 500 gallons per hour. Hardness on analysis 107.5 degrees, Clark's Scale.

*Brickyard Boring.* A little north-westward of Hathern Station, but in Sutton Bonnington parish, Nottinghamshire. Ht. above O.D., 135 ft.

Communicated by G. Hodson and published in 'The Geology of the Leicestershire and South Derbyshire Coalfield' (*Mem. Geol. Surv.*), 1907, p. 359.

		Thickness		Depth	
		Ft.	In.	Ft.	In.
[Keuper Marl]	{ Well ... ..	48	0	48	0
	{ Red marl ... ..	228	0	276	0
[L. Keuper S.]	Red sandstone and marl ...	106	0	382	0
[Permo-Trias]	{ Breccia ... ..	20	0	402	0
	{ Forest Rock ... ..	—	—	—	—

Mr. F. W. Hodson states that this boring was chiselled and had a diameter of only three inches. The conclusion that the Pre-Cambrian had been reached was based on a sample of 'Forest Rock' brought up from the depth of 402 ft. The second boring, made in 1930, proves that this fragment of 'Forest Rock' must have been a constituent of the Permo-Triassic Breccia. (See p. 99).

An analysis of water overflowing from this borehole (diameter, 9 in.) made by S. F. Burford on January 10th, 1903, revealed a total hardness of 168°.

William Keay visited this borehole on December 22nd, 1905. The top had recently been bared and an iron bellmouth was visible. The tube was blocked and filled in with bricks and rubbish. Water stood at a depth of 1.2 ft. from the top but was very foul.

*Brickyard Boring No. 2.* 135 ft. O.D. 20 ft. from No. 1 Boring (above) near Hathern Station, Notts. For Hathern Station Brick and Terracotta Co., Ltd., 15th August, 1929 to 12th February, 1930.

Chiselled to 220 ft., cores from 200 ft. to 605 ft. Communicated by F. W. Hodson, Esq., M.Inst.C.E.



		Thickness		Depth	
		Ft.	In.	Ft.	In.
Keuper Marl	Red marl in well ... ..	40	0	40	0
	Red marl ... ..	6	0	46	0
	Red marl, with gypsum ... ..	26	0	72	0
	Red marl, with green patches ... ..	17	0	89	0
	Red marl, with thin veins and bands of gypsum and thin shaly skerries	18	0	107	0
	Red and green marl ... ..	8	0	115	0
	Red marl with thin skerries ... ..	8	0	123	0
	Gypsum ... ..	0	3	123	3
	Hard skerry ... ..	0	6	123	9
	Red and green marl with gypsum ...	2	3	126	0
	Red marl with gypsum and skerries	4	0	130	0
	Red and green marl with bands and veins of gypsum and slightly micaceous skerries... ..	70	0	200	0
	Reddish-brown indurated marl, lam- inated and slightly contorted, with gypsum in veins, lenses and bands up to 1 in. in thickness, and green marl films with pseudo- morphs of salt crystals ... ..	15	6	215	6
	Hard fine-grained sandy and mic- aceous skerry with gypsum lenses	1	6	217	0
	Red and brown marl, laminated and indurated, with thin skerries, and gypsum bands up to 1½ in. ...	5	6	222	6
	Greenish-grey skerry, with veins and lenses of gypsum ... ..	1	0	223	6
	Reddish marl, with skerries up to 6 in., and gypsum veins and bands up to 1½ in. ... ..	9	6	233	0
	Hard greenish to grey skerry, with thin bands of reddish marl, and gypsum ... ..	3	0	236	0
	Reddish marl, fine-grained, sandy and micaceous ... ..	3	0	239	0
	Hard greenish to grey skerries, with a few thin red and green marl bands, a thin pseudo-conglomerate of marl flakes, and veins and lenses of gypsum ... ..	4	0	243	0
	Reddish-brown fine-grained sandy and micaceous marl to marly sand- stone, with a few gypsum lenses, and a thin basal pseudo-conglom- erate of sandy marl flakes and grit	7	0	250	0
	Reddish-brown fine-grained marly sandstone, with subordinate marls and gypsum lenses ... ..	5	0	255	0
	Reddish- to paler brown marly and micaceous sandstone, fine to medium-grained; rarely fissile or flaggy; partly current-bedded; with a few greenish 'eyes' and patches, thin grey sandy bands and dull red marly layers, and scattered lenses of botryoidal gypsum ...	31	0	286	0

		Thickness		Depth	
		Ft.	In.	Ft.	In.
Lower Keuper Sandstone	Reddish to paler-brown marly sandstone with subordinate marls, etc. as above, but less gypsum in lenses and granules ... ..	14	0	300	0
	Reddish-brown to dull red marly sandstones, softer than above, with a few thin greenish-grey bands and thin courses of sub-angular quartz grit ( $\frac{1}{8}$ to $\frac{1}{4}$ in.), also thin marl bands and numerous cavities up to 5 in. ... ..	16	0	316	0
	Reddish-brown marly and micaceous sandstone, fine to medium, and almost coarse-grained, partly greenish-grey mottled, and slightly current-bedded, with a few thin courses of sub-angular grit and scattered quartzite pebbles up to $\frac{1}{2}$ in. ... ..	14	0	330	0
	Reddish-brown sandstone, fairly soft, medium to coarse-grained, partly greenish-grey mottled and current-bedded, with scattered pebbles of brown or liver-coloured quartzite and a few pieces of decomposed green shale, etc. (up to $1\frac{1}{2}$ in.) (8 ft. of core represents $12\frac{1}{2}$ ft.) ...	12	6	342	6
	Deep red well-compacted sandy marl, partly green mottled, with soft sub-angular green shales or decomposed slates (up to 3 or 4 in.) and smaller rounded pebbles of quartzite, limestone, etc. ... ..	1	6	344	0
	Soft red and grey pebbly sandrock, mostly coarse-grained, with many sub-angular pebbles, up to 5 in., hard green hornstones, slates, and other Charnwood rocks, also Carboniferous limestone, and igneous rocks, etc., also smaller mostly rounded pebbles, up to 2 in., of liver-coloured quartzites, etc. (22 ft. of core represents 36 ft.) ...	35	9	379	9
Bunter Pebble Beds	Thin grey calcareous conglomerate, with small quartzite pebbles and pieces of green shale, etc., 2 in. to	0	3	380	0
	Soft red and grey pebbly sandrock, as above, but more marly and with smaller pebbles (4 ft. of core represents 10 ft.) ... ..	10	0	390	0
	Reddish marly and pebbly sandstone, with numerous flakes or chips of green hornstone and fewer of purple shale (up to $\frac{1}{2}$ in.); also angular Charnwood pebbles up to 1 in. (2 ft. of core represents 10 ft.) ... ..	10	0	400	0

		Thickness		Depth	
		Ft.	In.	Ft.	In.
(No cores were obtained between 400 and 438 ft., only unconsolidated residues)					
Permo-Trias Breccia	Red marly and quartzose sand with a few green chips of hornstone and slate. (Probably a sandstone similar to that above) ...	6	0	406	0
	Rusty brown, green tinged, loose fine breccia, of small angular chips of green Charnwood hornstones, etc. (rarely up to $\frac{1}{2}$ in.) with rusty brown coats ...	14	0	420	0
	Green loose fine breccia, with a faint rusty tinge, slightly coarser than that above, of angular chips ( $\frac{1}{8}$ to $\frac{1}{2}$ , rarely $\frac{1}{2}$ inch) of green, with fewer of pink and purple, Charnwood hornstones, felsites, etc., and a few of Carboniferous limestone ...	17	0	437	0
	Hard greenish-grey calcareous conglomerate, of sub-angular Charnwood hornstones, agglomerate, felsite and syenite, up to 6 in. and over, also grey and pink Carboniferous limestones, etc., and smaller pebbles (12 in. core at 438 ft. and 10 in. core at 441 ft. represents 7 ft.) ...	7	0	444	0
	Black bituminous shale, with a few thin sandy bands up to $\frac{1}{2}$ in. between 454 and 458 ft. Fish scales and remains, indet. goniatites and carbonised plant-remains. Iron pyrites, etc. ...	24	0	468	0
Millstone Grit (Eumorphoceras Zone, E2.)	Hard dark grey and black banded shale with sparry joints, with Eumorphoceras, Anthracoceras, Orbiculoidea, etc., at 470 ft. ...	5	0	473	0
	Black bituminous shale with a few thin hard black and grey bands. Fish scales and teeth, and plant-remains. Sutured Anthracoceras and Orthoceras at 480 ft. and indet. goniatites at 537 ft. ...	102	0	575	0
	Black bituminous stone band, with goniatites ...	0	6	575	6
	Black bituminous shale with a few thin fine-grained sandy bands, and indet. plant-remains ...	22	0	597	6
	Pale brown clay ironstone with septaria and macerated plant-remains. Dark oily matter in joints and cavities ...	0	6	598	0
	Black shale, with thin pale brown false-bedded calcareous sandstone bands and indet. plant-remains. Spar and oil in joints ...	1	6	599	6



	Thickness		Depth	
	Ft.	In.	Ft.	In.
Hard grey to brown quartzitic sandstone with indet. plants, sparry and oily joints ... ..	2	6	602	0
Dark shale with thin grey laminated fine-grained sandy bands. Indet. plants ... ..	3	0	605	0

A. Templeman classifies the strata of this boring as follows :—

	Thickness		Depth	
	Ft.		Ft.	
Keuper Marl ... ..	250		250	
Lower Keuper Sandstone ... ..	94		344	
Bunter Pebble Beds ... ..	62		406	
Permo-Trias Breccia ... ..	38		444	
Millstone Grit (Eumorphoceras Zone, E2) ...	161		605	

The Triassic strata are almost level throughout, but the Millstone Grit shales show a dip of 6° from top to bottom.

F. W. Hodson, Esq., *in litt.* 10.3.1920, states that "the 10 in. tubes were withdrawn, and 8 in. tubes put in to 199 ft. 7 in. below surface level, standing up in well, and these have been concreted in. The open boring from this depth to 605 ft. is 7½ in. diameter. At 286 ft. the water-level rose from 32 ft. to 19½ ft., at 344 ft. to 18½ ft., and at 444 ft. to 17½ ft.

"The test pumping gave a yield of 46,000 gallons per day, which reduced the water in the borehole from 17 ft. to 38 ft. below the surface, which was afterwards increased to 55,000 and then to 70,000 per day, which dropped the water to 50 ft. 4 in. below the surface."

The quality of the water is very hard, about 120 grains per gallon.

### III.—WATER SUPPLIES OF URBAN DISTRICTS

#### ASHBY-DE-LA-ZOUCH URBAN DISTRICT

Maps: 141, 155; (15 S.E., 16 N.W., S.W.)

The geology is described in detail in the 'Coalfield Memoir.'

The greater part of the district is on the Lower or Unproductive Coal Measures which were raised by an anticlinal fold (see p. 5), the axis of which runs through the town, so that the measures on the east dip to the north-east, and those on the west to the south-west. Although the measures have been little explored in Ashby and vicinity<sup>1</sup> it is known that they contain few coal seams and practically no water-bearing strata. There are no springs of any considerable size; the 'spring' near the Workhouse is a stream produced by surface drainage that disappears in dry weather. Traces of 'Permian' breccia and marl occur occupying hollows in the surface of the Coal Measures; also tracts, for example, east of Cliftonthorpe ('Ivanhoe Ho.' on the Geological Survey Map, Sheet 141), and between Ashby and Annie's Hole, floored with Lower Keuper Sandstone.

Since 1898 Ashby-de-la-Zouch has had a piped service from the Swadlincote and Ashby-de-la-Zouch Joint Water Board's reservoir at Woodville (capacity 1,185,000 gallons). Previous to 1898 the sources of supply were:

1.—Cliftonthorpe Reservoir, impounding water from a small spring (10,000 to 15,000 gallons per day) issuing on the north side of the reservoir; and

2.—Holy Well, a good spring (30,000 to 35,000 gallons a day, not now used) issuing from the base of the Lower Keuper Sandstone (resting on Coal Measures) at half-a-mile N.N.W. of the Church, Ashby-de-la-Zouch.

The water from both sources was piped to two small reservoirs at a pumping station on the site of the present Soap Works off The Calais, Ashby, from which it was pumped to a service reservoir on the water-tower in the present cemetery, whence it gravitated.

*Messrs. Ison, boring.* Information from Messrs. Le Grand, Sutcliff & Gell, Ltd., and published in 'Loughborough Memoir,' p. 67. 1892. Ht. above O.D., 420 ft.

						Thickness	Depth
						Ft.	Ft.
Soft sandstone	...	...	...	...	...	6	6
Red clay	...	...	...	...	...	12	18
Loamy sand	...	...	...	...	...	8	26
Sandstone and rock	...	...	...	...	...	6	32
Hard red clay	...	...	...	...	...	6	38
Soft sandstone	...	...	...	...	...	9	47
Hard red clay	...	...	...	...	...	23	70

[15 ft. of 4½ in. casing. Yield 720 gallons an hour.]

<sup>1</sup> Two borings have been made near Prestop Park Farm, of which details are given in the 'Coalfield Memoir,' pp. 312-314.

*Union Workhouse*, well on west side of. From Rev. Coleman's MSS. published in the 'Coalfield Memoir,' p. 314. Ht. above O.D., 400 ft.

						Thickness	Depth
						Ft.	Ft.
Soil, etc.	...	...	...	...	...	20	20
COAL	...	...	...	...	...	2	22
Rammelly bind	...	...	...	...	...	40	62
Boring at the bottom of a well, Ashby Union Workhouse.							
Stony grey bind	...	...	...	...	...	12	12
Grey stone	...	...	...	...	...	4	16
Stony bind...	...	...	...	...	...	7½	23½
Stone	...	...	...	...	...	3½	27

## SALINE SPRINGS

C. Fox-Strangways says<sup>1</sup>: "Several of the coal seams in the western part of the Coalfield exude salt water. This was noted many years ago with regard to the Main Seam at Moira; . . .

"The presence of this water does not appear to have been noticed until about 1832 [should be 1817] when the deeper mines at Moira had been sunk. The shallower pits do not yield saline water, but below 300 ft. it is mostly salt and very little fresh is obtained. The Moira pits do not give much water owing to the measures being broken up by numerous faults, which form barriers to the springs. It is found that when the salt water exists the coal seam is enclosed between layers of impervious clay, and that it is never found when the place of this clay is occupied by a sandstone. The water oozes from the coal seam and never runs freely, for which reason the coal is said to 'bleed.' "

Coleman states that salt water originally rose in the 'Salt Spring Close' at Donisthorpe, but that when the Double Pits were opened this spring was drained off.

Dr. A. B. Granville states<sup>2</sup> that the salt water was discovered in the Moira Colliery in 1817 at a depth of about 700 feet: "It is said to surge from various parts of the mine at the rate of about two hundred gallons an hour, but in slender streams." Some of the water was analysed and found to contain saline and other valuable ingredients. According to William White,<sup>3</sup> the "spring was discovered in 1805, during the progress of coal working, at the depth of about 700 feet" and "the beneficial qualities of the water, and the abundance of the supply, led, soon after the discovery of the spring, to the erection of the Moira Baths, and a commodious Hotel [now the Moirabaths Hotel (P.H.)] near the colliery. But these and several subsequent erections near the spring, were, after the lapse of a few years, found insufficient for the accommodation of the numerous visitors, . . ." Consequently the Ivanhoe Baths (completed, 1822<sup>4</sup>) and Royal Hotel were erected at Ashby-de-la-Zouch and the water was brought from the Moira Colliery "in carts or tanks, to . . . boats on the canal, and . . . thence conveyed on a truck to a large reservoir at the baths."<sup>5</sup> The Royal Hotel has been recently renovated, but the adjoining Baths have been converted into a garage.

The Ashby water had a strong saline taste and was used principally for bathing in. Analyses of it were made by Mr. Accum, Dr. Thomson, Dr. A. Ure, and Prof. G. C. B. Daubeney, who, in 1829, discovered bromine in it.<sup>6</sup> The following is Dr. Ure's analysis.<sup>7</sup>

<sup>1</sup> 'Coalfield Memoir,' p. 108.

<sup>2</sup> 'The Spas of England—Midland Spas,' 1841, p. 130.

<sup>3</sup> 'History . . . of Leicester,' 2nd ed., 1863, p. 440.

<sup>4</sup> 'The History and Description of Ashby-de-la-Zouch, etc.,' 1852, p. 109.

<sup>5</sup> Granville, Dr. A. B., 'The Spas of England. Midland Spas,' 1841, p. 132.

<sup>6</sup> *Phil. Trans.*, vol. cxx, 1830, p. 234.

<sup>7</sup> *Idem*, vol. cxxiv, 1834, p. 577.



## ANALYSIS OF WATER FROM THE MAIN COAL OF MOIRA

Bromide of potassium and magnesium	...	...	8.0
Chloride of sodium	...	...	3,700.5
Chloride of calcium	...	...	851.2
Chloride of magnesium	...	...	16.0
Chloride of potassium	...	...	0.0
Iron, as protochloride	...	...	a trace
Grains per imperial gallon	...	...	<u>4,575.7</u>

## ASHBY WOULD'S URBAN DISTRICT

Maps: 141, 155; (15 N.E., S.W., S.E., 22 N.E.)

The geology of the district is described in detail in the 'Coalfield Memoir.'

The district is on the Middle or Productive Coal Measures lying to the west of the Boothorpe Fault. Fox-Strangways says ('Coalfield Memoir,' p. 54): "In the Moira district higher measures come on than anywhere else in the coalfield. These contain several beds of coarse gritty sandstone, which crop out on the eastern side of the [Moira] collieries, being turned up by the great Boothorpe Fault. These sandstones were not met with in the colliery shafts, which is certainly curious, . . ." Detailed sections at the Moira Collieries are given on pp. 207-228 of the 'Coalfield Memoir.'

There are not any springs in the district worth mentioning; the few small streams that there are, are the product mainly of surface drainage, but into certain of them is pumped water from clay-pits.

There is a piped service throughout the district from the Swadlin-cote and Ashby-de-la-Zouch Joint Water Board's Supply: only a few outlying farms are dependent on wells.

## COALVILLE URBAN DISTRICT

Maps: 155; (16 S.E., 23 N.E.)

In the Urban District are Coalville, Whitwick, Hugglescote and Donington.

*Coalville Urban District Council's Supply.*—Works established 1905. Supplies Coalville Urban District (part), and furnishes a supply in bulk for some fifty houses and the Council Schools in Swannington parish (Ashby-de-la-Zouch Rural District). The supply is obtained from (1) a well with boreholes from the bottom at the Pumping Station near Spring Farm, under a mile S.E. by E. of Coalville; and (2) Water Shaft at Whitwick Colliery. The average daily quantity of water obtained is from (1) 240,000 gallons; and (2) 120,000 gallons, and the daily consumption is 360,000 gallons.

*Coalville Waterworks Pumping Station.*—Near Spring Farm. 1901-02. Ht. above O.D., 537 ft. 'Coalfield Memoir,' p. 350.

Well (78 ft. deep, 12 ft. by 8 ft.) with two boreholes from the bottom:—

		Thickness		Depth	
		Ft.	In.	Ft.	In.
[Boulder Clay with under- lying sand and gravel]	Yellow clay and stone ...	27	6	27	6
	Blue clay and chalk [fragments]	37	6	65	0
	Fine sand ...	15	0	80	0
	Gravel ...	5	0	85	0
	Sand and clay ...	19	0	104	0
	Sand, clay and sandstone ...	5	6	109	6
	Sandstone ...	3	6	113	0
	Red marl ...	29	0	142	0
	Sandstone band ...	0	8	142	8
	Red marl ...	17	4	160	0
	Hard grey sandstone ...	20	6	180	6
	Variegated sandstone ...	5	6	186	0
	Red marl ...	12	0	198	0
	Conglomerate ...	2	0	200	0
[Trias]	Red marl ...	9	0	209	0
	Conglomerate ...	3	6	212	6
	Grey sandstone ...	2	0	214	6
	Red marl ...	11	6	226	0
	Conglomerate ...	2	0	228	0
	Red marl ...	2	0	230	0
	Purple marl ...	11	0	241	0
	Variegated marl ...	19	10	260	10
	Green marl ...	5	0	265	10
	Green rock ...	—	—	—	—
[Dolerite]					
[Coal Measures.]					

## ANALYSIS

Coalville, Urban District Council's Supply, Pumping Station near Spring Farm.

				Grains per gallon
Total dissolved matter	...	...	...	31.92
Loss on incineration of residue	...	...	...	1.68
Chlorine in chlorides	...	...	...	2.00
(Equal to sodium chloride)	...	...	...	3.30
Nitrogen in nitrates	...	...	...	0.24
(Equal to nitric acid)	...	...	...	0.92
Free (actual or saline) ammonia	...	...	...	0.001
Albuminoid (organic) ammonia	...	...	...	0.001
Oxygen absorbed by oxidisable organic matter, etc., from a solution of permanganate of potash at a temperature of 80° Fahrenheit :				
In 15 minutes	...	...	...	0.006
In 4 hours	...	...	...	0.014
Phosphoric Acid	...	...	...	Traces
Appearance in 2-ft. tube	...	...	...	Clear
Total hardness	...	...	...	27°
Hardness after boiling	...	...	...	10½°

This water is of a high degree of bacteriological purity and is also chemically satisfactory.

Made by Dr. Bernard Dyer, 4th April, 1924.

*Whitwick Colliery: No. 6 Pit.* 1874-76. Ht. above O.D., 530 ft. The complete record, from George Lewis, is published in the 'Coalfield Memoir,' 1907, pp. 268-270.

				Thickness		Depth	
				Ft.	In.	Ft.	In.
[Trias]	{	Pit top raised	...	9	0	—	
		Red clay	...	3	0	3	0
		White sand...	...	32	0	35	0
		White clay	...	0	10	35	10
		Red clay	...	5	0	40	10
		White marl...	...	3	4	44	2
		Red clay	...	6	4	50	6
		White sandstone	...	3	6	54	0
		Water stone	...	3	0	57	0
		Red marl	...	38	0	95	0
[Whinstone <sup>1</sup> ]	{	White sandstone	...	4	0	99	0
		Red marl	...	92	3	191	3
		Granite or Diorite...	...	81	0	272	3
		Blue bind	...	12	0	284	3
[Coal Measures]	{	Black shale...	...	2	0	286	3
		Blue bind	...	4	0	290	3
		Black shale...	...	4	0	294	3
		Clunch	...	0	6	294	9
		COAL	...	0	1	294	10
		Measures and coals	...	687	5	982	3

## ANALYSES

Whitwick Colliery Shaft :—

1.—80 yards Spring or 'Main Supply' (240 ft. below the surface); from which (1.12.1913) about 250,000 gallons per day are pumped. Possibly about 10 to 12 per cent. of this comes from the 10-yard Spring. Analysis made 17.1.14.

2.—W. C. Tangye Spring. Small supply about equal to one per cent. of the bulk which is discharged into the Main Supply. 1.12.13.

3.—No. 1 Spring (over 390 ft. below the surface). 2.6.16.

4.—No. 2 Spring (390 ft. below the surface). 2.6.16.

5.—20-yard Spring. 14.10.16.

By Dr. Bernard Dyer, 17 Great Tower Street, London, E.C.

<sup>1</sup> In the shaft sunk in 1901 this rock was 61 ft. thick.



	Grains per gallon				
	1	2	3	4	5
Total dissolved matter ...	37.80	51.45	40.88	37.24	34.44
Chlorine in chlorides ...	1.60	10.40	1.70	1.50	1.50
Equal to sodium chloride ...	2.64	17.14	2.80	2.47	2.47
Nitrogen in nitrates ...	0.04	inap- preciable	inap- preciable	0.10	inap- preciable
Free ammonia ...	0.001	0.003	0.003	0.002	0.002
Albuminoid ammonia ...	0.001	0.003	0.001	0.001	0.001
Oxygen absorbed from solu- tion of potassium perman- ganate at 80°F. :					
In 15 minutes ...	0.010	0.069	0.007	0.010	0.010
In 4 hours ...	0.022	0.165	0.015	0.020	0.014
Phosphoric acid ...	traces	traces	traces	traces	traces
Appearance in 2-ft. tube ...	Not quite clear	turbid	clear	clear	clear
Microscopical examination	Some parti- cles of veget- able debris and a few living in- fursoria		A few organic parti- cles	A few organic parti- cles	A few minute organic parti- cles
Total hardness (degrees) ...	28		29	25	28.5
Permanent hardness ...	14		12	10	13
Bacteriological examination :					
Total number of organisms per cubic centimetre capable of growth in cold gelatine culture in 3 days	70	40,000	20	300	80
' Red ' colonies from 1 cc. in ' Rebigelagar ' medium (at blood heat)	None	impos- sible to estimate owing to the crowded inter- fering growth of other colonies	none	none	none
Results of M'Conkey broth- culture test for B. coli :					
In 100 c.c. ...	positive	positive	negative	positive	negative
,, 10 c.c. ...	negative	do.	do.	negative	do.
,, 1 c.c. ...	do.	do.	do.	do.	do.
,, 0.1 c.c. ...	do.	doubtful	do.	do.	do.

*Whitwick Waste*.—Shaft (128 ft.) and boring in corner of field about 240 yards west of Whitwick Waste Farm. Record (from J. A. Bosworth per W. Keay) published in the 'Coalfield Memoir,' pp. 350, 351; and information concerning water from W. Keay, July, 1926. Sunk May 6th, 1881.—January 9th, 1883. Ht. above O.D., 539 ft.

		Thickness	Depth
		Ft.	Ft.
[Boulder Clay with under- lying sand and gravel]	Drift [with fragments of Lias and Chalk <sup>1</sup> ]	30	30
	Strong blue clay	2	32
	Dry loose gravel	58	90
	Loose gravel (very wet)	12	102
	[Very] fine wet sand...	16	118
	Red and grey marls	17	135
	Hard white sandstone [crossed N.N.E. by 2-inch fissure which continued to bed below]	7	142
	Drab sandstone rock	15	157
	Hard red marl	16	173
	Red marl (wet)	4½	177½
[Probably Lower Keuper Sandstone]	Grey rock (very wet) [full of water holes]	3	180½
	Grey conglomerate	5	185½
	Hard red marl	1	186½
	Very hard conglomerate	5	191½
	Dry red marl	11	202½
	Grey sandy binds [with fragments of syenite. Much water]	7	209½
	[No water below this]		
	Grey conglomerate (angular pebbles)	15	224½
	Red marl	11	235½
	Hard red marl	11	246½

Water.—Put down 11-inch pump works to 10½ clear 5-ft. stroke, 12 strokes per minute (15.3.1882).

7-inch pump works 6½, 5-ft. stroke, 14 per minute (22.3.1882).

Took out for analysis one Winchester gallon, drew out first plug ¾-inch bore, water rose in 7-ft. shaft 2 ft. 6 in. in 25 minutes.

*South Leicestershire Colliery, No. 2 Pit*.—Ht. above O.D., 510 ft. The complete record, from W. Melling, is given in the 'Coalfield Memoir,' pp. 285-288; of the White Pit, also from W. Melling, *idem*, pp. 282-285.

		Thickness	Depth
		Ft. In.	Ft. In.
Soil	...	1 0	1 0
Clay	...	3 0	4 0
Red marl and grey sandstone	...	5 0	9 0
Grey sandstone	...	1 0	10 0
Red marl	...	6 0	16 0
White sandstone	...	2 0	18 0
Red marl	...	10 0	28 0
Red marl and sandstone	...	2 6	30 6
Red marl	...	8 0	38 6
White sandstone	...	6 0	44 6
Strong red marl and sandstone	...	10 0	54 6
Red marl (water 6 gals. a minute)	...	21 4	75 10
Red marl and sandstone	...	3 0	78 10

<sup>1</sup> Information in square brackets from W. Keay, July, 1926.

## LEICESTERSHIRE WELLS

				Thickness		Depth	
				Ft.	In.	Ft.	In.
[Probably Keuper Marl.]	Red marl	...	...	14	6	93	4
	Red marl and sandstone	...	...	3	0	96	4
	Red marl	...	...	3	1	99	5
	Red marl and sandstone (water 17	...	...	...	...	...	...
	gals. a minute)	...	...	3	6	102	11
	Red marl	...	...	5	6	108	5
	Red marl and sandstone	...	...	4	11	113	4
	Red marl	...	...	5	9	119	1
	Sand rock (water 6 gals. a minute)	...	...	0	6	119	7
	Red marl and sandstone	...	...	16	4	135	11
	Red marl	...	...	4	0	139	11
	White sand (water 8 gals. a minute)	...	...	1	3	141	2
	Red marl	...	...	17	1	158	3
	White sandstone (water 9 gals. a	...	...	...	...	...	...
	minute)	...	...	1	9	160	0
[Whinstone]	Red marl	...	...	11	4	171	4
	Red marl and sand	...	...	3	4	174	8
	Red marl	...	...	1	2	175	10
	Red marl and sand	...	...	1	10	177	8
	Strong sand rock	...	...	1	3	178	11
	Red marl and sand	...	...	2	3	181	2
	Green rock (water 20 gals. a minute)	...	...	16	4	197	6
	Soft white stone (water 5 gals. a	...	...	...	...	...	...
	minute)	...	...	2	4	199	10
	Fire clay	...	...	7	8	207	6
[Coal Measures]	Rattlejack	...	...	3	2	210	8
	COAL No. 1	...	...	0	8	211	4
	Measures and coal seams	...	...	671	8	883	0

Approximate quantity of water pumped daily, practically all from the Trias, 100,000 gallons. (W. Keay).

*Hugglescote Boring.*—Trial boring for coal made on the land of L. Fosbrooke, 1830, between two cottages and a pond half-a-mile north of the letters 'es' in Hugglescote on the 6-inch Map, 63 N.W. Ht. above O.D., about 514 ft. The complete record, from the Rev. W. H. Coleman's MSS., is given in the 'Coalfield Memoir,' pp. 279-282.

				Thickness		Depth	
				Ft.	In.	Ft.	In.
Soil and clay	...	...	...	1	6	1	6
Red marl and freestone, etc.	...	...	...	58	6	60	0
Red stone	...	...	...	1	0	61	0
White stone	...	...	...	2	3	63	3
Red marl	...	...	...	11	4	74	7
White stone	...	...	...	2	7	77	2
Brown stone	...	...	...	1	3	78	5
Red marl	...	...	...	20	0	98	5
Brown stone	...	...	...	5	1	103	6
Red marl	...	...	...	2	6	106	0
Grey stone	...	...	...	1	6	107	6
Red marl	...	...	...	3	5	110	11
Stone	...	...	...	4	2	115	1
Red marl	...	...	...	3	9	118	10
Freestone	...	...	...	12	4	131	2
Strong marl	...	...	...	33	3	164	5
White stone	...	...	...	1	5	165	10
Red marl	...	...	...	10	5	176	3
Brown stone	...	...	...	1	8	177	11



	Thickness		Depth	
	Ft.	In.	Ft.	In.
Red stone ...	2	0	179	11
Stony marl ...	3	5	183	4
Freestone ...	1	5	184	9
Shed ...	0	3	185	0
Stone ...	2	3	187	3
Shed ...	0	5	187	8
Stone ...	0	4	188	0
Shed ...	0	3	188	3
Stone ...	0	6	188	9
Red marl ...	6	3	195	0
Freestone ...	0	9	195	9
Red marl ...	1	9	197	6
Pink mixture ...	4	3	201	9
Blue bind ...	2	9	204	6
Brown stone ...	0	3	204	9
Blue bind ...	2	6	207	3
Dark bind ...	17	6	224	9
Stone bind ...	11	6	236	3
Ironstone ...	0	2	236	5
Strong blue bind ...	4	5	240	10
Ironstone ...	0	3	241	1
Blue bind ...	4	0	245	1
Ironstone ...	0	1	245	2
Blue bind ...	1	7	246	9
Black shale ...	1	2	247	11
Blue bind ...	1	10	249	9
Ironstone ...	0	2	249	11
Blue bind ...	2	3	252	2
COAL—Stone Smut Coal ...	3	4	255	6
Measures and coal seams ...	213	5	468	11

*Hugglescote, Well at.*—In a well at Hugglescote over thirty feet of Chalky Boulder Clay was found resting on gravel.<sup>1</sup>

## ANALYSIS

W. Griffin's spring from the New Red Sandstone in Donington, Jan. 4, 1872. 'Sixth Report, Rivers Pollution Commission. The Domestic Water Supply of Great Britain, 1874,' p. 116.

	Parts per 100,000
Total solid impurity ...	33·86
Organic carbon ...	0·104
Organic nitrogen ...	0·207
Ammonia ...	0·0
Nitrogen as nitrates and nitrites ...	0·234
Total combined nitrogen ...	0·261
Previous sewage or animal contamination ...	2,020
Chlorine ...	1·40
Hardness : Temporary ...	19·8
Permanent ...	15·9
Total ...	35·7

*Remarks.*—Clear and palatable.

On p. 356 of their report the Commissioners remark : " William Griffin's spring in Donington affords water of good quality for drinking and culinary purposes, but too hard for washing. As this is a spring water the moderate amount of previous animal contamination may be disregarded, it arises from manured land and not from sewage."

<sup>1</sup> 'Atherstone Memoir,' p. 37 ; 'Thicknesses of Strata' (*Mem. Geol. Surv.*), 1916, p. 80.

## HINCKLEY URBAN DISTRICT

Maps : 155, 169 ; (35 S.E., 42 N.W., N.E., S.W., S.E.)

Hinckley Urban District is floored with Glacial deposits. From the associated gravel many small springs issue, some of which are 'petrifying,' others chalybeate. Dr. Mervyn Patterson said<sup>1</sup> : "The Ancient Royal Town of Hinckley has long been famed for its pure springs, amongst which we may mention 'Cogg's Well,' 'Christopher Spa,' 'Priest's Hill,' and 'Holy Well.' Mr. Hollier appears to have been so fortunate as to have discovered a *Chalybeate Spring*, possessed of most valuable properties. . . ."

*Cogg's Well* is on the Park Farm near Forest View ; it is reputed to have petrifying properties, but is certainly slightly chalybeate as the water makes a reddish ferruginous deposit on the bed of the brook that runs from the spring down by the hedge. The site of *Christopher Spa* is in the garden of cottages<sup>2</sup> on the north side of Bowling Green Road (off Spa Lane). *Holy Well* was at the top of the Burbage Road near the junction of Spa Lane : a large conical brick pump stood on the site until about thirty-five years ago, but now nothing is to be seen. A spring west of the Ashby Road that gave rise to a streamlet that flowed down Barwell Lane used to be resorted to by people with eye troubles : water was taken away in bottles. The *Hinckley Baths* were erected in 1848 and stood on the site now occupied by the Mineral Baths Hotel<sup>3</sup> : Dr. Charles Cowdell described the water as 'Sulphureous-Saline-Carbonated-Chalybeate' (analysis, below).<sup>4</sup>

## ANALYSIS

*Hinckley Mineral Spring*

Specific gravity ... ..	1.0011
Temperature at the well ... ..	52°
Gaseous contents of an imperial pint, $3\frac{3}{10}$ cubic inches; consisting of—	
	Inches
Sulphuretted hydrogen ... ..	0.4
Carburetted hydrogen ... ..	0.1
Nitrogen ... ..	1.1
Carbonic acid ... ..	1.7
	3.3
The solid contents of an imperial pint are 9 grains :—	
	Grains
Sulphates, 2 grains, viz. :	
Sulphate of lime ... ..	1.55
Sulphate of alumina ... ..	0.45
Nitrate of soda ... ..	0.20
Chlorides, 2.50 grains, viz. :	
Chloride of sodium ... ..	1.15
Chloride of calcium ... ..	0.60
Chloride of magnesium ... ..	0.50
Chloride of manganese ... ..	0.25
Phosphate of lime ... ..	0.15
Carbonate, 3 grains, viz. :	
Bicarbonate of lime ... ..	2.10
Carbonate of magnesia ... ..	0.65

<sup>1</sup> 'A Medical Guide to the Hinckley Mineral Spring and Baths,' August 1849, preface.

<sup>2</sup> On a stone built into the cottage wall is cut "1761. Hinckley Fields Enclosed," but there can just be made out on the stone "Chr" of "Christopher Spa."

<sup>3</sup> On the Ashby Road.

<sup>4</sup> 'Hinckley Mineral Water' (leaflet bearing the date) Oct. 12, 1848.

	Grains
Protocarbonate of iron	0.25
Sulphuret of iron	0.11
Silica	0.08
Organic matter or vegetable extractive	0.66
Loss upon whole	0.30
	<u>9.0</u>

Made by Isaiah Deck for Mr. Hollier, of Hinckley, 13.12.1847. Deck said :—

“ From its prevailing characteristics it may be classed as a sulphuretted chalybeate, and while I would point attention to the unusual presence of Nitrate of Soda and Phosphate of Lime, the proportions of the other more common ingredients must not be overlooked, especially the Bicarbonate of Lime, . . .

“ The Chloride of Manganese I have before assured myself of the presence of in many other waters, though not in so large a quantity as in this.”

*Battling Brook* is a good stream maintained by springs from the Glacial sands.

*Hinckley Urban District Council's Supply.*—Works completed August, 1891. Supplies Hinckley U.D. (part), and parts of parishes of Snarestone, Sweptstone (Ashby-de-la-Zouch R.D.), and Market Bosworth (Market Bosworth R.D.); and furnishes a supply in bulk to Hinckley R.D.C.

Sources of Supply.—Two shafts with headings in Triassic sandstone and conglomerate at Snarestone, 13 miles N.N.W. of Hinckley. The average daily quantity of water obtained is 400,000 gallons. Analysis, p. 113.

Owing to the increasing demand for water and the falling off in yield at Snarestone arrangements were made with the Nuneaton Corporation to augment the supply (see p. 116) and the additional water became available in October, 1926.

During the year 1927 the total consumption of water was 174,333,600 gallons, the Hinckley Rural District Council taking 52,950,000 gallons.

*Snarestone Pumping Station.*—Ht. above O.D., 314 ft.

Two shafts, about 80 ft. apart (the original shaft being an old coal shaft<sup>1</sup> 534 ft. deep, with a 3-inch borehole at the bottom for a further 312 ft.), the pilot well (shaft) being connected to the original shaft by a northern heading.

	Original shaft	Pilot Well
Year in which sunk	1878	1908
	Ft.	Ft.
Depth of shaft	534	138
Diameter of shaft	12	8
Depth of borehole from bottom of well	312	—
Depth below surface to roof of headings	124	124
Lengths and directions of headings	—	495 ft. E., 962 ft. W.
Water levels : rest	112 ft.	
after pumping 18 hrs.	123 ft.	
Yield combined	430,000 gallons per 24 hrs.	

As analysis showed that water below the 120 ft. level contained from 17 to 20 grains per gallon of common salt<sup>2</sup> an oak floor was inserted at 130 ft. down

<sup>1</sup> The complete record of the strata penetrated is given in the 'Coalfield Memoir,' pp. 335-338. The depth of the shaft and boring is there given as 866 ft. 1 in.; E. H. Crump gives (*Trans. Inst. Water Eng.*, vol. xvii, 1912, p. 134); shaft 534 ft.; borehole, 312 ft.—total 846 ft.

<sup>2</sup> Fox-Strangways says ('Coalfield Memoir,' p. 109), that the salt water comes "in a seam possibly the Main. . . ."



and water is pumped from about 100 ft. down. The original yield from the original shaft at this depth was over 360,000 gallons per day, but by January, 1905, it had decreased to 295,000 gallons per day. So the pilot well was sunk and two headings driven. The combined yield of shaft, pilot well, and northern heading was 450,000 gallons per day. In the eastern heading at a point 75 yds. from the pilot well, the supply suddenly increased to 700,000 gallons per day, which remained constant after six weeks continual pumping. So the driving of headings was discontinued and the works completed on February 20th, 1910. By 1925, however, the yield had fallen off to 400,000 gallons a day (see p. 116).

*Original Shaft.*—Disused coal shaft (diameter 12 ft.; depth 534 ft.) and borehole (diameter, 3 in.; depth, according to E. H. Crump, 312 ft., to W. Molyneux, 332 ft. 1 in.). Site marked on map half-a-mile N.E. by N. of the Church, Snarestone. Ht. above O.D., 314 ft.

The detailed record is given in the 'Coalfield Memoir,' pp. 335-338. A portion, down to the first coal seam, is here given.

					Thickness		Depth	
					Ft.	In.	Ft.	In.
					1	6	1	6
					4	0	5	6
					4	0	9	6
					4	6	14	0
					5	0	19	0
					9	0	28	0
					4	0	32	0
					3	0	35	0
					4	0	39	0
					6	0	45	0
					6	0	51	0
					12	0	63	0
[Lower Keuper Sandstone and Bunter]	Red sand rock				4	0	67	0
	Light sand rock				3	0	70	0
	Strong rock marl				10	0	80	0
	Red marl rock with pebbles and stones				19	0	99	0
	Red marl parting (100 gals. of water per minute)				0	3	99	3
	Red sand rock with pebbles				10	0	109	3
	Red marl parting (200 gals. of water per minute)				0	6	109	9
	Red sand rock with pebbles				17	3	127	0
	Red sand rock				18	0	145	0
	Red rock				11	0	156	0
[Coal Measures]	Red marl				3	0	159	0
	Red and mingled rock				13	6	172	6
	Red rock with water				5	6	178	0
	Red and mingled rock				45	0	223	0
	Blue marl				5	0	228	0
	Ironstone (cank)				0	3	228	3
	Rocky bind				12	0	240	3
	Clunch bind				5	6	245	9
	Black shale...				4	0	249	9
	Ironstone (inferior)				0	5	250	2
	Black shale...				3	0	253	2
	Dark clunch				3	0	256	2
	COAL				3	6	259	8
	Measures and coal seams				606	5	866	1

*Pilot Well*. 1908-09. See E. H. Crump, *Trans. Inst. Water Eng.*, vol. xvii, 1912, p. 156.

						Thickness		Depth	
						Ft.	In.	Ft.	In.
[Lower Keuper Sandstone and Bunter]	1. Marl	...	...	...	...	15	0	15	0
	2. Sandstone	...	...	...	...	5	10	20	10
	3. Marl	...	...	...	...	19	3	40	1
	4. Sandstone	...	...	...	...	1	0	41	1
	5. Marl	...	...	...	...	0	9	41	10
	6. Sandstone	...	...	...	...	4	0	45	10
	7. Marl	...	...	...	...	0	9	46	7
	8. Sandstone	...	...	...	...	2	0	48	7
	9. Marl	...	...	...	...	1	3	49	10
	10. Sandstone	...	...	...	...	4	2	54	0
	11. Marl	...	...	...	...	0	6	54	6
	12. Sandstone	...	...	...	...	14	9	69	3
	13. Marl and sandstone	...	...	...	...	6	1	75	4
	14. Marl	...	...	...	...	5	10	81	2
	15. Sandstone	...	...	...	...	2	0	83	2
	16. Marl	...	...	...	...	6	9	89	11
	17. Gravel	...	...	...	...	7	6	97	5
	18. Marl	...	...	...	...				
	19. Conglomerate	...	...	...	...				
	20. Marl	...	...	...	...				
	21. Conglomerate	...	...	...	...	6	0	103	5
	22. Marl	...	...	...	...	4	0	107	5
	23. Marl and sandstone	...	...	...	...	16	7	124	0
	24. Conglomerate (fine)	...	...	...	...	14	0	138	0
	25. Conglomerate (mixed)	...	...	...	...				

## ANALYSES

## Public Supply.

1.—From original shaft. E. H. Crump, *Trans. Inst. Water Eng.*, vol. xvii, 1912, p. 149.

2.—From both shafts and headings. Ditto.

3.—Ditto. 24 September, 1923.

	Parts per 100,000		
	1	2	3
Free and saline ammonia	0·0	0·1	trace
Organic ammonia	0·002	0·004	0·010
Chlorine in chlorides	10·7	7·3	9·400
Nitrogen in nitrates or nitrites	0·11	trace	trace
Total solid matter	50·0	50·0	54·00
Hardness: Temporary	8·85	5·15	14·7
Permanent	24·00	22·10	18·8
Total	32·85	27·25	33·5

*Holy Well Boring*.<sup>1</sup>—In Urban District Council's yard opposite Spa Lane. 1875. Ht. above O.D., 425 ft.

Hinckley Local Board per James Plant, *Rep. Brit. Assoc.* for 1875 (1876), p. 136; *idem* for 1879 (1880), p. 160; C. E. De Rance, *Trans. Manchester Geol. Soc.*, vol. xv, 1878, p. 95; 'Coventry Memoir,' p. 100.

## Summary of particulars:—

Well, (30 ft., diameter 6 ft.) and boring (520 ft., diameter 11 in. to 4 in.) :—

<sup>1</sup> This boring has been called in MSS. the "London Road Boring."

					Thickness	Depth
					Ft.	Ft.
Glacial	{	Chalky Boulder Clay ...	...	...	50	50
		Red sands, loams and clays ...	...	...	50	100
		Brown silt ...	...	...	50	150
		Red Boulder Clay ...	...	...	3	153
Upper Keuper	{	Upper Keuper or Arden Sandstone ...	...	...	30	183
		Marl with gypsum ...	...	...	217	400
Lower Keuper		Sandstone ...	...	...	150	550

Rest-level for four years, 100 ft. down. Yield: no estimate, well not used.

This boring was sunk by the Hinckley Local Board in search of a supply for Hinckley.

*Hinckley Wharf<sup>1</sup> Boring*.—Site marked on map one mile W.S.W. of Hinckley. Ht. above O.D., 313 ft.

James Plant, *Rep. Brit. Assoc.*, for 1882 (1883), pp. 226, 227; *idem* for 1883 (1884), pp. 154, 155; *idem* for 1887 (1888), p. 364; J. D. Paul, *Trans. Leicester Lit. and Phil. Soc.*, vol. i, pt. 3, 1887, p. 13 (analysis of water); 'Coventry Memoir,' pp. 99, 127.

Well (12 ft.) and boring :—

Commenced Nov. 1877 (10-in. to 161 ft. ; 7in. to 473 ft.)	473 ft.
Deepened Nov. 1881-82 (but not tubed) to ...	754 "
Deepened Sept.-Oct., 1883 (3-in. bore) to ...	805 "

Summarized section :—

					Thickness	Depth
					Ft.	Ft.
Glacial Deposits		...	...	...	88	88
Keuper Marl	{	Upper Keuper or Arden Sandstone ...	...	...	12	100
		Red gypsum marls with bands of grey sandstone ...	...	...	396	496
		Lower Keuper Sandstone { Red, grey, and brown sandstones with bands of marl ...	...	...	309	805

Water-level 80 feet down ; yield 400,000 gallons per day (530 grains solid : 39 grains chlorine).

This was a second boring made by the Hinckley Local Board in search of a supply for Hinckley—first to a depth of 473 ft.<sup>2</sup> with unsatisfactory results.

In 1879 James Plant was engaged to report on likely sources of supply.<sup>3</sup> He considered sites for impounding reservoirs on the Harrow Brook near its junction with the River Anker at Paul's Ford, and on the River Tweed a little north of Hopewell and south of Ambien Hill, but ultimately recommended the widening and deepening of The Wharf Boring. In 1881-82 the boring was deepened to 754 ft.,<sup>4</sup> but the water obtained had a " brackish taste " (analysis p. 116).

In 1883 the Board consulted T. S. Stooke of Shrewsbury, who first carried out experiments at The Wharf Boring.<sup>5</sup> Water was found to be standing at 80 ft. down. Between April 16th and 23rd, 1883, and again between May 4th and 19th, 400,000 gallons were pumped. According to Dr. Emmerson the

<sup>1</sup> 'Port House,' or 'Coventry Road' Boring.

<sup>2</sup> See *Rep. Brit. Assoc.* for 1887 (1888), p. 364.

<sup>3</sup> 'Report on the Water Supply for the Town of Hinckley, Leicestershire, from the Underground Sources of the Triassic Formation,' *Hinckley*, 1879.

<sup>4</sup> *Rep. Brit. Assoc.* for 1883 (1884), p. 154 ; see also *idem* for 1882, p. 226.

<sup>5</sup> *Rep. Brit. Assoc.* for 1883 (1884), p. 155.

<sup>6</sup> Stooke, T. S., 'On a Borehole in Leicestershire,' *Min. Proc. Inst. C. E.*, vol. xc, 1887, pp. 30-34.



first sample of water contained 530 grains of solids and 39 grains of chlorine to the gallon ; the last showed a reduction in solids to 65 grains, but an increase of 2 grains in chlorine.

" Small nodules of gypsum were traced in the cores of sandstone . . . to a depth of 680 ft. from the surface ; it was therefore considered desirable to prove the lower measures by further boring, and a 3-inch hole was carried down [4th Sept.-9th Oct., 1883] from 754 feet to 805 feet. The last 50 feet indicated more favourable water-bearing strata than any previously met with."<sup>1</sup>

Stooke had a plug placed at 690 ft. down with a view to shutting out the higher water and pumping only, what was hoped would be the less saline, lower water. The results, as shown by Dr. Emmerson's analysis, were as follows :—<sup>2</sup>

	Gallons.	Grains of solids per gallon	Grains of chlorine per gallon
Nov. 6th when about	2,500 were pumped	170	13
Dec. 3rd	30,000	384	25
" 5th	48,000	425	26·3
" 7th	65,000	395	27
" 10th	108,000	504	26·5

" The pumping has not shown the satisfactory result that was so much desired, and it is rather remarkable that the solids and chlorine have increased as the greater amount of water has been drawn off. The increase of the saline taste has been apparent. . . "

The plug was therefore lowered to 731 ft. from the surface, but analysis showed solids ranging from 390 to 475 grains per gallon and about 27 grains of chlorine to the gallon.<sup>3</sup> Stooke was of opinion that water from the upper strata must have found its way to the pump through natural fissures in the rock ; but the writer's experience is that water in the Lower Keuper Sandstone when beneath a thick covering of Keuper Marl generally has a high sodium chloride content which increases as lower ' strata ' of water are drawn on owing to over-pumping.

As the water from The Wharf Boring was a mineral or medicinal water the borehole was abandoned and Stooke investigated the district for a source of supply. On March 31st, 1884, he submitted his report.<sup>4</sup> He considered ' Seaswood [Seeswood] Pool,' about two miles to the south-westward of Nuneaton, and the impounding of the waters of the (1) Tweed, near Dadlington ; (2) Soar ; and (3) Anker, near the Sinny Fields. He said : " Either of these three water-sheds are available for supplying water to Hinckley provided that proper Storage Reservoirs of sufficient capacity are constructed. After careful examination of these streams, and their tributaries, I consider the ' Soar ' to possess the greatest advantages for the following reasons, viz. :—that it has a gathering ground of about 4,000 acres. The streams possess the cleanest and purest appearance, . . . That an eligible site for an impounding reservoir exists on the stream between ' Mickle Hill ' on the north, and ' The Shade ' on the south. This water-shed includes ' Foster's Pool,' which is situated on the head gathering ground of the ' Soar,' but which is of itself, much too limited in area for it to be selected as the source of the water supply for the Town."

After considering well and borehole schemes he recommended a well in the Lower Keuper Sandstone between The White Stone and the Ashby-de-la-Zouch Canal on the south because " It appears to me that with a well about 150 feet in depth, and a borehole carried down from it, possibly another

<sup>1</sup> Stooke, T. S., *Min. Proc. Inst. C. E.*, vol xc, 1887, p. 31.

<sup>2</sup> Report [to the Hinckley Local Board], December 12th, 1884.

<sup>3</sup> Stooke, T. S., *Min. Proc. Inst. C. E.*, vol. xc, 1887, p. 33.

<sup>4</sup> ' Report [to the Hinckley Local Board], with Plan, on Hinckley Water Supply, p. 5, and sketch map. 1883. *Privately printed.*

100 feet, that a supply of from 3 to 400,000 gallons daily may be anticipated."

A well was accordingly sunk near The White Stone and a boring carried from the bottom but the quantity of water obtained was inadequate.

In April, 1887, the Council became aware that a supply of water was available in a disused coal shaft at Snarestone, about 14 miles distant from Hinckley. This had been tested by the Leicester Corporation as a probable supply for that city, but had been abandoned by them partly on account of insufficiency of quantity, and partly on account of the excessive hardness and the large quantity of total solid matter, including common salt, in the water, especially in that obtained from the lower portion of the shaft.

In September, 1887, Messrs. T. & C. Hawksley<sup>1</sup> advised the Board to purchase the shaft at Snarestone and use the water. The necessary Act was obtained in July, 1888, and the works opened in August, 1891 (see pp. 111-113).

By 1925, however, the yield from the Snarestone Works had fallen off to 400,000 gallons a day. In a paper prepared by J. S. Featherstone, Surveyor, Hinckley U.D.C. for a meeting of the East Midland District of the Institution of Municipal and County Engineers, at Hinckley, 24th May, 1928, it is stated:—

"Until 18 months ago the whole of the water supply was obtained from a disused coal shaft at Snarestone, a village about 13 miles north of Hinckley. The yield of this well was originally 360,000 gallons per day, and this had been increased on two occasions to 600,000 gallons per day by driving headings. Unfortunately this increased yield was not maintained, and by 1925 only 400,000 gallons per day were available. Barwell, Earl Shilton and Burbage, three growing villages in the Hinckley rural district, are supplied with water in bulk. The increasing demand for water and the decreasing yield of the well brought about a serious situation, necessitating a system of rationing and causing much anxiety to the water department. Fortunately, the Corporation of Nuneaton had a surplus of water available through their recent arrangement with Leicester to take a supply from Thornton Reservoir. To tap this supply, it was only necessary to lay a 9-in. main from a point on the Leicester-Nuneaton pumping main to the town service reservoir, a distance of four miles. This was done, and the additional water became available in October, 1926."

*Hinckley Wharf Boring.*

ANALYSIS						In parts per 100,000
Lime	...	...	...	...	...	67·31
Soda	...	...	...	...	...	202·50
Magnesia	...	...	...	...	...	19·00
Sulphuric acid	...	...	...	...	...	295·60
Carbonic acid	...	...	...	...	...	16·67
Silicic acid	...	...	...	...	...	2·00
Chlorine	...	...	...	...	...	61·70
Total	...	...	...	...	...	664·78

The above constituents are considered to be combined in the water as follows:—

In parts per 100,000					
Sodium chloride	...	...	...	...	101·67
Sodium sulphate	...	...	...	...	340·39
Calcium sulphate	...	...	...	...	163·47
Magnesium sulphate	...	...	...	...	11·50
Magnesium carbonate	...	...	...	...	31·85
Silicic acid	...	...	...	...	2·00
					650·88
Add oxygen equal to chlorine	...	...	...	...	13·90
Total	...	...	...	...	664·78

<sup>1</sup> From Crump, E. H., 'The Hinckley Waterworks,' *Trans. Inst. Water Eng.*, vol. xvii, 1912, pp. 132, 133.

Made by A. Bostock Hill and published in *Rep. Brit. Assoc.* for 1883 (1884), pp. 154, 155.

*Hinckley [Wharf] Boring.*

	In grains per gallon
Chloride of sodium	71.2
„ potassium	traces
Sulphate of soda	238.3
„ magnesia	8.0
„ lime	114.4
Carbonate of magnesia	22.3
Silica	1.4
Total solids	455.6

Made by A. Bostock Hill and published by J. D. Paul in *Trans. Leicester Lit. and Phil. Soc.*, vol. i, pt. 3, 1887, p. 13.

*Messrs. Atkin's Hosiery Factory*, Bond Street. 1913-14. Map 42 N.E.  
Ht. above O.D. about 410 ft.

		Thickness Ft.	Depth Ft.
	1. Top soil	2	2
	2. Chalky boulder-clay	10	12
	3. Sand and loamy sand	29	41
	4. Sand and running sand, light brownish-yellow	11	52
	5. Red-brown clay, sandy	3	55
	6. Grey-brown sand	5	60
	7. Brown silty clay...	10	70
Drift	8. Loams and clays, very fine, light-brown	10	80
	9. Brown silty clay (as No. 7)	9	89
	10. Reddish-brown silty clay	11	100
	11. Dark-brown clay	10	110
	12. Light-brown clay	18	128
	13. Dark-brown clay with pebbles of ironstone and grit and patches of red marl	7	135
	14. Light-red marl with green spots and small pebbles	25	160
Keuper Marl	15. Light-green and red marls with thin bands of limestone	30	190
	16. Red marls with green mottling...	8	198
	17. Coarse grit	3	201
	18. Marls with gypsum	22	223
Upper Keuper or Arden Sandstone	19. Hard grey sandstone, fine-grained	2	225
	20. Hard red marl	19	244
	21. Sandstone (as No. 19)	5	249
	22. Hard sandstone, close-grained	7	256
	23. Red marl without gypsum	34	290
	24. Red marl with green spots and traces of gypsum	10	300
Keuper Marl	25. Hard red marl	8	308
	26. Harder red marl with conchoidal fracture		Undetermined

Old sunk well 41 ft.; boring, 267 ft.—total 308 ft. Rest-level of water about 80 ft. down. Pumping-test at a depth of 305 ft. yielded 1,400 galls. an hour during which the water-level stood at 140 ft. down.



Boring made by Messrs. Peacock & Bird, Hinckley. The above record was published by A. J. Pickering.<sup>1</sup>

*Leicester Grange Medicinal Springs.*—Leicester Grange is in the Warwickshire parish of Burton Hastings some two miles south of Hinckley.

The springs around Leicester Grange issue from the Glacial sand and gravel, find their way into Foster's Pond, and give rise to one of the sources of the River Soar. When Dr. Aldridge lived at the Grange he built near one of the springs a bath for the use of his patients, as the water was reputed to possess medicinal qualities.

### MARKET HARBOROUGH URBAN DISTRICT

Maps : 170 ; [63 S.E., 64] ; (50 N.E.)

In 1883 G. E. Mawbey remarked<sup>2</sup> : “. . . this [Urban] district is situate on the Blue [Lower] Lias formation, and . . . most of the drinking water is ‘Surface Water’ derived from thin beds of drift gravel, and from the loamy soil overlying the Blue Lias clay, which is met with at an average depth of about seven feet from the surface, . . . the water is collected in shallow wells sunk a few feet into the blue clay for storage. In this subsoil from which the drinking water is supplied, is laid the old system of sewers and house drainage.”

On December 4th, 1890, the Council's supply came into operation.

*Market Harborough Urban District Council's Supply.*—Sources of Supply (Nature and Sufficiency).

(1) Old Supply : wells (in Lower Lias), etc. (see below), North Kilworth and Husbands Bosworth ;

(2) New Supply : wells in gravel overlying Lower Lias, North Kilworth. The average daily quantity of water available from each source is respectively, (1) 160,000 gallons, (2) 120,000 gallons (estimated).

Works.—Service reservoir :—Burn Mill Hill, Great Bowden, 500,000 gallons.

Quantity of water supplied.—The daily average is 170,000 gallons.

Quality of water.—Analyst remarks (7th June, 1913) that the water is excellent. Hardness, 30°. (Analysis, p. 120).

#### Particulars of Sources of Supply

##### 1. *Old Supply.*

(a) *Main well* (diameter, 8 ft.) near windpump on west side of stream near Hill's Barn, North Kilworth. Ht. above O.D., 480 ft.

Glacial	Gravel	...	...	...	...	} 26 ft.
Lower Lias	{ Clay	...	...	...	...	
	{ Limestone : about 1 ft.	...	...	...	...	

Only a small quantity of water was found in the gravel. On the higher ground is gravel occupying a depression in the Lower Lias. A heading runs from near the bottom of the well, through a Lower Lias clay band into the

<sup>1</sup> ‘On two Borings for Water at Hinckley, Leicestershire,’ *Geol. Mag.*, 1916, pp. 68-70.

<sup>2</sup> ‘Reports on the Existing Water Supply of the Market Harborough, Great and Little Bowden Local Board District,’ 1883.

gravel bed which forms—according to H. G. Coales—a reservoir estimated to hold 7,000,000 gallons.

Yield (estimate), 110,000 gallons per day. Water-level 7 ft. down. If the main well only is drawn on the water is lowered in summer down to the bellmouth, but if not drawn on for 24 hours the water recovers its previous rest-level.

(b) *Well* (diameter, 8 ft.) in Catfollon Spinney on east side of stream S.E. of Hill's Barn in Husbands Bosworth parish. Ht. above O.D., 472 ft.

Glacial	Gravel	...	...	...	...	22 ft.
Lower Lias	{	Boring from the bottom of the well				
		pierces Lower Lias limestone below.				

Yield (estimate), 50,000 gallons per day. Water-level 12 ft. down, but when drawn on varies from bellmouth to several feet. The wells are built waterproof, except where provision has been made for the admission of water wherever it appeared in the excavation.

The water from both wells is conveyed by two 7-inch iron pipes to the valve house situate in Husbands Bosworth parish where commences the 10-inch supply main to Market Harborough.

## 2. *New Supply.*

(a) *Well* (diameter, 8 ft.) a quarter of a mile eastward of Grange Farm, North Kilworth. Ht. above O.D., 467 ft.

Glacial	Gravel	...	...	...	...	25 ft.
Lower Lias						

Yield (actual, by meter), 66,000 gallons per day. Rest-level 10 ft. down. In this well the water is run right down to the bellmouth when it only refills slowly, according to the rainfall.

This well collects water from a gravel bed of about 45 acres in extent situate in a hollow in the Lower Lias. H. G. Coales ascertained that 30 acres contains water varying from 3 to 12 ft. in depth. When the L. & N.W.R. constructed their Market Harborough to Rugby Line they removed the gravel from an area of about 25 acres to an average depth of 12 ft. and originated the present 'old ballast hole.' Toward the centre of this old pit is the main well of this part of the New Supply. Some water is piped from the gravel bed west of the road into the old pit and delivered into a portion of the gravel so that it becomes naturally filtered before it reaches the catch-water pipes and wells connected with the main well. From the main well the water runs through a 7-inch pipe to the valve house in Husbands Bosworth parish.

(b) *Grange Farm Well*, near Grange Farm, North Kilworth. Information from Herbert G. Coales, A.M.I.C.E., Surveyor, Market Harborough Urban District Council. Ht. above O.D., 488.39 ft. Sunk 1926-7.

						Thickness	Depth
						Ft.	Ft.
Well (diameter, 7 ft.), bricked :—							
Glacial	Gravel	...	...	...	...	55	55
Lower Lias	{	Limestone, blue-hearted, ferruginous ;				0½	55½
		belemnites, <i>Ostrea</i> sp. : 6 to 9 in. ...					
			Clay, blue				

Yield.—Tested to 240,000 gallons per day. Rest-level 37.5 ft. down from the surface ; fell by end of test to 50 ft. ex surface ; recovered original level 12 hours after cessation of test. Estimated average daily yield, 120,000 gallons. The lithic character and fossil content of the limestone suggest a *capricornus* or slightly later date.

## ANALYSES

Public Supply.

1. From Old Supply main well (a).

2. From Old Supply well in Catfollon Spinney, Husbands Bosworth (b).

Appearance in 2-ft. tube ... ..					1	2
					Clear. No marked colour. Grains per gallon	Clear. No marked colour. Grains per gallon
Total solid matters	...	...	...	...	44.8	34.3
a. Volatile	...	...	...	...	18.2	12.6
b. Fixed	...	...	...	...	26.6	21.7
Total hardness	...	...	...	...	23.8	21.7
a. Permanent	...	...	...	...	12.6	7.7
b. Temporary	...	...	...	...	11.2	14.0
Chlorine	...	...	...	...	0.98	0.98
Equivalent to common salt	...	...	...	...	1.614	1.614
Nitrogen as nitrates	...	...	...	...	0.065	0.098
Saline (or 'free') ammonia	...	...	...	...	0.0021	0.00098
Organic (or 'albuminoid') ammonia	...	...	...	...	0.00392	0.00364
Poisonous metals	...	...	...	...	absent	absent
Microscopic examination of the sediment					A very little mineral matter	A very little mineral matter

Remarks.—No perceptible browning of solid matters on heating.

*Gas Works.*—According to Alfred T. Harris<sup>1</sup> "The supply, for the works, was originally obtained from a dyke or watercourse running along the east side of the works, the water required being diverted from its course into a well in the Gas Works. The dyke has now been filled in, the water not required by the Gas Department being conveyed into the river Welland through 24-inch diameter glazed pipes laid in the ground.

"During 1901 a well was sunk on a piece of land adjoining York Street, purchased from Mrs. Holloway in 1899.

"A good supply of water was found, the average yield being 30,000 gallons per diem, with a minimum of 25,000 gallons during the dry summers of 1911 and 1913.

"Since 1902 the water required for the swimming bath, street watering, road making and market cleansing, has been obtained from the Gas Works supply and during the summer months over 200,000 gallons of water per week is frequently supplied for the above purposes.

"A disused gas holder tank is used as an underground reservoir."

<sup>1</sup> 'Market Harborough Gas Works,' *Market Harborough Urban District: Public Undertakings and Statistics, 1880-1913.*



## MARKET HARBOUROUGH

Public Supply (p. 118).

- 1, 2. Old Supply: wells 1 and 2 or (a) and (b) mixed.  
 3. New Supply: well 3 or (a)  
 4. " " Grange Farm (near) Well, (b). 4-7 during sinking of well.

	[In grains per gallon]						
	1, 2	3	4	5	6	7	
Date	29.5.24	29.5.24	31.5.26	25.5.26	16.7.26	21.9.26	
Total dissolved matter	39.76	22.96	31.36	32.76	33.04	36.68	
Loss on incineration of residue	1.96	1.68	2.24	3.08	2.24	2.52	
Chlorine in chlorides	1.30	1.20	1.00	1.05	1.10	1.10	
(equal to Sodium chloride)	2.14	1.98	1.65	1.73	1.81	1.81	
Nitrogen in nitrates	0.14	0.19	0.38	0.34	0.36	0.29	
(equal to nitric acid)	0.54	0.75	1.46	1.40	1.40	1.14	
Free (actual or saline) ammonia	0.001	0.001	0.001	0.001	0.001	0.001	
Albuminoid (organic) ammonia	0.001	0.001	0.003	0.001	0.001	0.001	
Oxygen absorbed by oxidisable matter, etc., from a solution of permanganate of potash at a temperature of 80°F.:							
in 15 minutes	0.006	0.009	0.028	0.015	0.008	0.006	
in 4 hours	0.012	0.020	0.054	0.027	0.017	0.012	
Phosphoric acid	Traces	Traces	Traces	Traces	Traces	Traces	
Appearance in 2-ft. tube	Clear	Clear	Turbid	Turbid	Pract. clear	Clear	
Total hardness	29½°	16°	26°	—	26°	28°	
Hardness after boiling	13½°	15½°	8.5°	—	8.5°	10°	

Made by Dr. Bernard Dyer.

## MELTON MOWBRAY URBAN DISTRICT

Maps: 142; (13 S.W., 20 N.W., S.W.)

This district is on Boulder Clay, which rests on Lower Lias, except alongside the River Wreak where it is floored with Alluvium. The town of Melton Mowbray is situate almost entirely on this Wreak-side Alluvium.

*Melton Mowbray Urban District Council's Waterworks.*—Established 1886. Gravitation supply; supplies Melton Mowbray Urban District. Information from W. H. Jarvis, Engineer and Surveyor, Melton Mowbray Urban District Council.

Sources of Supply (Nature and Sufficiency):—

- (1) Springs from sand and gravel associated with Boulder Clay, Scalford;
- (2) Gathering ground, 300 acres, Scalford;
- (3) Gathering ground and springs from the base of the Marlstone, Scalford (added 1907).

The average daily quantity of water derived from each source is respectively:—

- (1) 20,000 gallons a day and a further 60,000 gallons a day can be obtained for several months.

- (2) 86,000 " " " 50,000 " " "

- (3) 53,000 " " " 50,000 " " "

Works.—Filtration at (3) only, 1,500 gallons per sq. yd. per day.

Reservoir.—Scalford, 1,000,000 gallons. Pressure is sufficient.

Quantity of water supplied.—The daily average is 176,500 gallons. Supply is constant.

Quality of water.—The Analyst remarks (20th August, 1920) that chemically the figures are fully up to standard of sound drinking water, and that bacteriologically the readings are equally satisfactory. Hardness—total 19·470; permanent 7·10. No action on lead; contains some iron.

Public Supply.

## MELTON MOWBRAY

Date of analysis—Aug. 11th, 1920. Number of analysis—1721/24, 1920.

Nature of examination.	Town supply, parts per 100,000	Old supply, parts per 100,000	New supply, parts per 100,000	Pumping station supply, parts per 100,000	Analysis taken in Feb., 1911, parts per 100,000
Total solid matter in solution	42·4	40·2	33·8	44·4	35·75
Loss on ignition ...	—	—	—	—	—
Chlorine as chlorides ...	2·0	2·0	2·4	2·0	2·0
Free or saline ammonia ...	·0006	·0024	·0012	·0015	Trace
Albuminoid ammonia ...	·0008	·0036	Nil	·0005	·012
Oxygen consumed in 15 minutes at 37°C. ...	·0013	·0064	·0039	·0026	Trace
Oxygen consumed in 4 hours at 37°C. ...	·0184	·0206	·0171	·0146	·02
Nitrogen as nitrates and nitrites ...	·317	·315	·229	·295	·26
Nitrogen as nitrites ...	Nil	Nil	Nil	Nil	Nil
Organic nitrogen by Kjeldahl	—	—	—	—	—
Hardness:—					
Temporary ...	21·52	21·521	17·51	24·52	16·22
Permanent ...	6·406	6·406	6·006	7·007	8·0
Appearance in 2-ft. tube ...	Clear	Clear	Clear	Clear	Clear
Smell... ..	Nil	Nil	Nil	Nil	Nil
Sediment ... ..	Nil	Nil	Nil	Nil	Slight earthy

## CONCLUSIONS

Town Supply.—A very satisfactory sample and free from organic pollution.

Old Supply.—A satisfactory water and fairly free from pollution. The figures of the free and albuminoid ammonia are higher than obtained from the "Town" and "Pumping Station," but not excessive. It is not of such high quality as the "New Supply."

New Supply.—This is a good water and free from organic pollution. It is quite suitable for domestic use.

Pumping Station.—A very satisfactory sample and free from pollution.

Made by Mr. Harold Spitta, St. George's Hospital Medical School, London. 23rd August, 1920.

'Town Trial Boring,'—Trial-boring for town supply by the Scaford Road, about 200 yards W. of the Great Northern Station, Melton Mowbray. Information from Messrs. Le Grand, Sutcliff & Gell, Ltd. Commenced 1882, finished March, 1883. Map 20 N.W. Ht. above O.D., about 260 ft.

Rep. Brit. Assoc. for 1883 (1884), pp. 153, 154. The following account is reproduced from the 'Melton Mowbray Memoir,' p. 106, which account was abridged from that published in 'Geology of S.W. part of Lincolnshire, etc.' (Mem. Geol. Surv.), 1885, pp. 147-148.

Boring (diameter, about 4 in.):—				Thickness		Depth	
				Ft.	In.	Ft.	In.
	Soil	...	...	2	0	2	0
Post Glacial ?	Loam, clay, sand and gravel	...	...	12	0	14	0
Glacial	{ Blue clay and stones [Boulder	...	...	24	0	38	0
	Clay]	...	...				
Lower Lias	Blue clay, shale and stone	...	...	230	8	268	8
Rhaetic	Dark shaly clay and stone	...	...	16	4	285	0
Keuper	{ Grey marl and stone [Tea-green	...	...	24	0	309	0
Marl	marls]	...	...				
	Red marl, with beds of grey marl,	...	...	223	10	532	10
	grey sandstone and gypsum	...	...				

"Water rises to 120 feet below the surface, from the gypsum beds as well as the sandstone."<sup>1</sup>

Pipes— 53 ft. of 4-inch tubing, top 1 ft. 6 ins. below surface.

356 ft. of 3-inch tubing, top level with surface.

In the 'Melton Mowbray Memoir,' p. 35 (footnote), it is stated: "Two different versions of this boring are extant; . . . The two versions were published in Rep. Brit. Assoc. for 1883 (pp. 153-4) as two distinct borings, and are described as such in "The Jurassic Rocks of Britain," vol. iii, Mem. Geol. Surv., 1893, p. 171, and elsewhere in geological literature; though in the Survey memoir on "The Geology of the South-west Part of Lincolnshire," 1885, pp. 147-8, where both readings are reproduced, it is recognised that they refer to the same boring; and nothing is known locally of two separate borings. An independent account of this section has been communicated to us by Mr. Baldwin Latham, M.I.C.E., who received it from Mr. Johnstone, surveyor, of Melton Mowbray, who watched the boring. This account, in which depths only are given, substantiates in all material respects the version previously supplied on the authority of Messrs. Le Grand & Sutcliff, except in the lowest two or three feet, and in giving less detail of the uppermost 14 ft. There is every reason therefore to believe that Messrs. Le Grand & Sutcliff's version gave the correct reading of the sinkers' record. The other version, in which the hypothetical geological divisions are stated without detail, besides differing somewhat from the above in matter of depth, is widely divergent in interpretation, for while the former assigns only 38 ft. to drift deposits, the latter gives 149 ft. of drift, with corresponding lower levels, for the bases of

<sup>1</sup> 'Leicester Memoir,' p. 93.



the Lias and Rhaetic. The evidence of the surrounding country renders it very improbable that the drift attains at this spot the depth allotted to it in the second version, and we therefore adopt the first-mentioned record as being the more trustworthy."

*Alnhurst, Welby Lane.* Made by, and information from, Messrs. Le Grand, Sutcliff & Gell, Ltd. 1917. Map 20 N.W. Ht. above O.D., 376 ft.

No. 1 Boring (diameter, 5 in.) :—

				Thickness	Depth
				Ft.	Ft.
[Boulder Clay and associated sand]	Blue drift	...	...	104	104
	Sandy clay	...	...	8	112
	Dark sand	...	...	1	113
	Dark stony clay	...	...	13½	126½

Water-level 86 to 96 ft. down.

No. 2. Well and boring (5 in.) :—

				Thickness	Depth
				Ft.	Ft.
[Boulder Clay and associated sand and gravel]	Loam	...	...	1	1
	Chalk and gravel	...	...	13	14
	Sandy clay	...	...	3	17
	Chalky clay and gravel	...	...	28	45

24 ft. by 4 ft. well. Stone cylinders.

Water-level 2½ ft. down. Yield 60 gallons per hour.

#### OADBY URBAN DISTRICT

Maps : 156 ; (37 N.E., S.E., 38 N.W., S.W.)

This Urban District is floored with Boulder Clay with associated sand and gravel (resting on Lower Lias) and Lower Lias.

Some 600 out of 700 houses have Leicester City water laid on.

#### QUORNDON URBAN DISTRICT

Maps : 142, 156 ; (17 S.E., 18 N.W., S.W., 25 N.W.)

Quorndon is situate for the most part on river-gravel (terrace) alongside the River Soar. The Urban District, however, spreads also over Alluvium, Boulder Clay, and Keuper Marl, through which last projects the granitic mass of Buddon Wood.

Nearly all the houses in the district are supplied with water, purchased in bulk by the Council, from Leicester City Council. Only a few shallow wells are in use and there are no boreholes.

#### ANALYSES

1.—Quorn Field's Farm, near Pilling's Lock, Leicester Canal. New well in Alluvium. By S. F. Burford.

				Parts per 100,000
Appearance in 2-ft. tube	...	...	Colourless after descending	
Odour...	...	...	Slight	
Reaction	...	...	Nil	
Metals (=lead, iron, copper)	...	...	Nil	
Chlorine	...	...	1.33	
Nitrites	...	...	Nil	
Nitrogen as nitrates, etc.	...	...	Nil	
Ammonia	...	...	0.0040	
Albuminoid ammonia (total distillate)	...	...	0.0185	
Oxygen absorbed from permanganate in 15 min.	...	...		
at 80°F.	...	...	0.0520	
Total solids dried at 220°F.	...	...	—	
Hardness (in degrees, Clark's Scale)	...	...	47	
Microscopical examination of deposit	...	...	Earthy	

"I am of opinion that this water may be used for drinking and for domestic purposes. The water is somewhat hard but may be rendered much softer by boiling."

2.—Water from excavation in Alluvium at Quorndon. By S. F. Burford.

	Grains per gallon
Date ... ..	17.7.1896
Appearance in 2-ft. tube ... ..	Cloudy, brownish
Odour when heated to 100°F. ... ..	None
Chlorine ... ..	3.19
Nitrites ... ..	Abundant
Nitrogen as nitrates, etc. ... ..	1.40
Ammonia ... ..	0.0074
Albuminoid ammonia ... ..	0.0215
Oxygen absorbed in 15 min. at 80° Fahr. ... ..	0.0790
Total solid matter dried at 220° Fahr. ... ..	53.9

*Remarks.*—This sample is charged with organic matter and is not fit for drinking.

### SHEPshed URBAN DISTRICT

Maps: 141, 155; (10 S.W., 17 N.W., N.E., S.W., S.E.)

The northern portion of this district is on Keuper Marl, which is obscured locally by Boulder Clay (with associated sand and gravel); Lower Keuper Sandstone emerges from beneath the Marl southward of the town in the vicinity of the railway; while the southern portion of the district includes part of Charnwood Forest in which Pre-Cambrian rocks project through a mantle of Keuper Marl and locally Keuper Sandstone.

Shepshed has Loughborough Corporation water, but many of the houses in the district, particularly the outlying properties and farms, are still supplied by wells.

*Piper Wood Boring.*—Sites indicated on Geological Survey Map (New Series), Sheet 141. Ht. above O.D., about 230 ft.

The complete records, ex Rev. W. H. Coleman's MSS., are given in the 'Loughborough Memoir,' 1905, pp. 55-58, and repeated in the 'Coalfield Memoir,' pp. 355-358. The information is difficult to interpret: Fox-Strangways said in a Report (typescript), 1903:—

"A boring to the north of Shepshed reached the [Lower Keuper] sandstones beneath the [Keuper] marl at about 350 feet, but does not appear to have met with any [Bunter] Pebble beds. If this is correct it would seem that the Pebble beds thin out in this direction and therefore any boring put down in search of water should be kept to the Soar Valley. . . ."

And in the 'Coalfield Memoir,' that the Millstone Grit was apparently penetrated (p. 17) and the Carboniferous Limestone "appears to have been reached . . ." (p. 15).

The following interpretation of Coleman's MSS. records is based on the above-quoted remarks of Fox-Strangways:—

	Thickness	Depth
	Ft.	Ft.
Upper Keuper Marl: about ... ..	350	350
Lower Keuper Sandstone (? and representative of		
Millstone Grit): about ... ..	105½	455½
? Carboniferous Limestone ... ..	24½	480

## THURMASTON URBAN DISTRICT

Maps: 156; (25 S.E., 31 N.E.)

Thurmaston is situate on river-gravel (terrace), but the Urban District extends over Keuper Marl on which rest locally deposits of Glacial sand, Boulder Clay, and, margining the River Soar, Alluvium.

424 out of 443 houses have Leicester City water laid on.

*Brickyard Well.*—Sunk by H. Herbert, February, 1925.

							Thickness	Depth
							Ft.	Ft.
Alluvium	...	...	...	...	...	...	5	5
Keuper marl.	Marl	...	...	...	...	...	25	30
	Skerry	...	...	...	...	...		

Rest-level of water, 20 ft. below the surface. Good supply from the skerry at the bottom.

## WIGSTON MAGNA URBAN DISTRICT

Maps: 156; (37 N.W., N.E., S.W., S.E.)

This Urban District contains two populous parts—Wigston Magna and South Wigston. The former is situate on Glacial sand; the latter mainly on Boulder Clay—both resting on Lower Lias.

1834 out of 1950 houses in the District are supplied with Leicester City water.

## SOUTH WIGSTON

*Leicestershire Dairy Co.*—Boring made by, and information from, Messrs. C. Isler & Co., Ltd.

							Thickness	Depth
							Ft.	Ft.
[Lower Lias and Rhaetic]	{	Made ground	...	...	...	...	4	4
		Blue layers of limestone	...	...	...	...	84	88
[Keuper Marls]	{	Red marl and gypsum	...	...	...	...	48	136
		Shale and gypsum	...	...	...	...	64	200

103½ ft. of 8-inch (perforated) and 46½ ft. of 8-inch (plain) tubing—total 150 feet, top 3 ft. down. Water-level 15 ft. down.



#### IV.—MUNICIPAL BOROUGH OF LOUGHBOROUGH

Maps : 141, 142 ; (10 S.E., 11 S.W., 17 N.E., S.E., 18 N.W., S.W.)

The Borough spreads over Soar-side Alluvium, gravel of a river terrace, Keuper Marl (locally obscured by Boulder Clay), and, in the south-west, Pre-Cambrian rocks ; but the town of Loughborough is almost entirely on the river-terrace gravel.

*Loughborough Town Council.*<sup>1</sup>—Supplies Loughborough B. (part), Shepshed U. D. (part), and parts of the parishes of Nanpanton and Prestwold (Loughborough R. D.).

Sources of Supply (Nature and Sufficiency).—

(1) Wood Brook (a stream rising in Charnwood Forest) with gathering-ground, 1,050 acres, Nanpanton.

(2) Blackbrook with gathering-ground 2,867 acres, two miles south-westward of Shepshed.<sup>2</sup>

The average daily quantity of water obtained is 669,573 gallons, and a further 1,580,000 gallons per day could be obtained.

Works.—Filtration, 279 gallons per square yard per day. Storage reservoirs :—Nanpanton, 29,000,000 gallons (completed 1870) ; Blackbrook, 506,000,000 gallons (completed 1906). Service reservoirs :—Nanpanton, 321,000 gallons ; Blackbrook, 121,000 gallons.

Quantity of water supplied (year ending 31st December, 1926).—The daily average was 896,000.

Quality of water.—Good. Hardness :—Total, 10·43° ; permanent, 7·14°. No action on lead.

##### ANALYSES

Blackbrook Reservoir impounding water from a gathering-ground of 2,867 acres floored with Pre-Cambrian rocks, Keuper Marl, Lower Keuper Sandstone and traces of Boulder Clay.

1.—Reservoir ; 2.—Top end of reservoir ; 3.—Near dam. By William T. Burgess.

					Parts per 100,000		
					1	2	3
Date	...	...	...	...	8.10.07	24.1.06	24.1.06
Total solid residue	...	...	...	...	23·94	24·68	24·80
Organic carbon	...	...	...	...	·460	·357	·616
Organic nitrogen	...	...	...	...	·032	·034	·051
Ammonia, free and saline	...	...	...	...	Nil	·004	·024
Ammonia, albuminoid	...	...	...	...	·014	·014	·025
Oxygen consumed (4 hrs. at 80°F.)	...	...	...	...	·227	·195	·373
Nitrogen as nitrates	...	...	...	...	·018	·272	·258
Nitrogen as nitrites	...	...	...	...	Nil	Nil	Nil
Total combined nitrogen	...	...	...	...	·050	·309	·329
Combined chlorine	...	...	...	...	1·50	1·80	1·75
Hardness : Temporary	...	...	...	...	8·0	5·0	2·0
Permanent	...	...	...	...	9·3	11·5	12·0
Total	...	...	...	...	17·3	16·5	14·0

<sup>1</sup> ' Return as to Water Undertakings in England and Wales,' *Local Gov. Bd.*, 1915, pp. 84, 85 ; Hodson, G. and F., ' Loughborough Corporation Waterworks—The Blackbrook Dam,' *Trans. Assoc. Brit. Waterworks Eng.*, vol. vii, 1902, pp. 203-209.

<sup>2</sup> Minimum dry weather flow of the Blackbrook, about 300,000 gallons per day. Compensation water, 30,000 gallons per day.

*Remarks.*—1.—Organic matter somewhat high but simply of vegetable origin ; 2.—Slightly turbid ; 3.—Turbid.

*Loughborough Sewage Farm, Knight Thorpe.*—About one mile from Loughborough. By trial (see A. S. Butterworth, *Proc. Inst. C. E.*, vol. cxxv. 1896, p. 368) the nature of the ground was found to be :—

						Thickness	Depth
						Ft.	Ft.
[Alluvial Deposits]	{	Soil	...	...	...	1½	1½
		Clean sand	...	...	...	4	5½
		Gravel gradually increasing in thickness				9½	15
		Clay, proved to	...	...	...	25	40

## V.—COUNTY BOROUGH OF LEICESTER

Maps : 156 ; (31 N.W., N.E., S.W., S.E., 37 N.W., N.E.)

The city extends over a variety of rocks : Alluvium, margining the River Soar and the lower reaches of its tributaries ; Superficial Deposits—river gravel (terrace) and Boulder Clay with its associated (mainly underlying) sand and gravel ; and the 'solid' rocks—Keuper Marl, Rhaetic (Spinney Hills), and Lower Lias (Crown Hills).

The greater part of 'old' Leicester is situate on gravel of a river terrace that in turn rests on Keuper Marl. Records reveal that supplies from shallow wells (below 30 ft. in depth) in this gravel are likely to be irregular in quantity, hard, and contaminated. Cases may occur in which the normal rest-level of water in a well may unexpectedly rise. In some instances such apparently inexplicable rises may be due to trenches having been dug in the vicinity and the beaten-down filling-in material functioning temporarily as a dam.

The nature of the 'solid' rocks beneath the city will be seen from the summaries of records of deep borings given on page 141.

In the Keuper Marl is a bed of sandstone—the Upper Keuper Sandstone. This sandstone varies considerably in thickness from place to place and locally appears to be absent. Typically it consists of :—

			Ft.
Upper Sandstone Shales	...	...	16
Middle Sandstone	...	...	14
Lower Sandstone Shales	...	...	11

James Plant<sup>1</sup> was of opinion that the deep wells (below 90 ft. in depth) in the city derived their constant though limited supplies from this Sandstone, "which dips S.E. at a low angle from the outcrop, on Davies Hill, towards the town and river," which supplies, though free from organic impurity, are hard from sulphate and carbonate of lime.

In 1893 Montagu Browne gave a very detailed account of "The Geology of the Borough of Leicester,"<sup>2</sup> in which he collected together records of well-sinkings obtained by himself and others—notably James Plant<sup>3</sup> and J. D. Paul. Certain particulars of the majority of the well-sinkings proving Upper Keuper Sandstone are given on p. 142.

The Keuper Marl was proved at the Willow Brook Boring (see p. 141) to be 640 ft. thick : locally it may be more or less. It contains many veins and layers of gypsum ; water is often encountered in some quantity on piercing a thick layer of gypsum but is so hard from the presence of calcium sulphate as to be unfit for domestic purposes.

<sup>1</sup> *Rep. Brit. Assoc. for 1875 (1876)*, p. 118.

<sup>2</sup> *Trans. Leicester Lit. and Phil. Soc.*, vol. iii, pt. 4, 1893, pp. 123-240.

<sup>3</sup> *Reps. Brit. Assoc. for 1875, 1878, 1880, 1889.*



The Lower Keuper Sandstone (? 39 to 105 $\frac{2}{3}$  ft.) contains water but apparently irregularly. Probably the water is carried in fissures and could soon be overpumped. When the Willow Brook Boring had penetrated to 4 ft. of the upper limit of the Sandstone "pure" water was encountered which "[?] rose 20 feet above top of borehole." The Knighton Fields Boring, which went for a depth of at least 39 feet into the Sandstone (according to the Engineers, Messrs. Mather & Platt) "failed to yield any supply of water whatever," and "there is no water in the borehole at all, except what has trickled in from the well."<sup>1</sup>

The Lower Keuper Sandstone, with locally associated breccia, rests on highly inclined dark shaly and slaty beds which are considered to be of Silurian or Cambrian age.

*The Leicester Spa.*—The site of the Leicester Spa is 40, The Spa, Humberstone Road. The well is beneath the house but is not now in use. Doubtless the medicinal water came from the river gravel.

William White, in his 'History . . . of Leicester . . .,' 2nd ed., 1863, p. 179, says: "A sulphureous spring was discovered about 1787, at *Spa place*, in Humberstone road, and its water was said to possess similar properties to those of Harrogate and Kedleston, but it did not remain long in repute, and was disused many years ago."

At the beginning of June, 1793, and at the same season in the following year, an advertisement appeared in the Leicester *Herald* calling attention to the therapeutic properties of the Leicester Spa water,<sup>2</sup> but how long the water remained available to the public is not on record.

*Leicester City Council.*—Supplies (Water Area) Leicester C. B.; Oadby U.D., Thurmaston U.D., Wigston Magna U.D.; parishes of Anstey, Anstey Pastures, Barkby, Barrow-on-Soar, Beaumont Leys, Birstall, Cossington, Cropston, Gilroes, Leicester Frith, Mountsorrel, Newtown Linford, Rothley, Seagrave, Sileby, Swithland, Syston, Thurmaston, Wanlip, Woodhouse (Barrow-on-Soar R.D.); Burton Overy, Rushby, Evington, Glen Magna, Humberstone, Newton Harcourt, Stoughton, Stretton Magna, Stretton Parva, Thurnby, Wistow (Billesdon R.D.), Blaby, Braunstone, Braunstone Frith, Cosby, Countesthorpe, Croft, East Leicester Forest, Wigston East, Enderby (bulk by agreement), Foston, Glenfield, Glenfield Frith, Glen Parva, Huncote, Kilby, Kirby Frith, Kirby Muxloe, Lubbesthorpe, Narborough, New Parks, Scraptoft, West Leicester Forest, Whetstone (Blaby R.D.), Bagworth, Groby, Ratby, Stanton-under-Bardon, Thornton (Market Bosworth R.D.), Fleckney, Kibworth Beauchamp, Kibworth Harcourt, Smeeton Westerby (Market Harborough R.D.), and furnishes supplies in bulk to Nuneaton B., Quorndon U.D., and Blaby R.D.C. (for Enderby parish).

Sources of Supply (Nature and Sufficiency).—

(1) Gathering ground, 2,860 acres over Drift and red Keuper Marl, Thornton, ten miles from Leicester;

(2) Gathering ground, 4,400 acres, principally over red Keuper Marl, but also over Drift and Pre-Cambrian rocks (Bradgate Park), Cropston, six miles from Leicester;

(3) Supply in bulk from the Derwent Valley Water Board (added in 1912);

(4) Gathering ground, 3,500 acres over Drift, red Keuper Marl and Pre-Cambrian Slates, Swithland, nine miles from Leicester.

<sup>1</sup> Browne, Montagu, *Trans. Leicester Lit. and Phil. Soc.*, vol. iii, pt. 4, 1893, p. 200.

<sup>2</sup> Johnson, Mrs. T. Fielding, 'Glimpses of Ancient Leicester in Six Periods,' 1896, p. 400 (footnote).

The average daily quantity of water derived from each source was respectively for the year ending December 31st, 1925 :—(1) 675,353 galls., (2) 1,510,305 galls., (3) 6,608,117 galls. ; (4) is an emergency supply.

Works.—Filtration, 300 gallons per square yard per day. Storage reservoirs: Thornton, 333,000,000 gallons (constructed by Water Company in 1854 and purchased by Corporation in 1878) ; Bradgate, 556,000,000 gallons (constructed by Water Company, 1870, and purchased by Corporation in 1878) ; Swithland, 490,000,000 gallons (constructed 1876) (not used but kept in reserve). Service reservoirs: New Parks, 2,000,000 gallons ; Gilroes, 2,000,000 gallons ; Oadby, 1,000,000 gallons ; Hall Gates, 4,000,000 gallons ; Evington, 5,000,000 gallons ; Aylestone, 1,000,000 gallons. Pressure is sufficient.

Quantity of water supplied (year ending December 31st, 1925).—The daily average was 8,435,527 gallons, and 358,249 gallons in bulk. Supply is constant.

Quality of water.—Analyses (as per average of analyses made from the three sources in use)<sup>1</sup> :

A.—Generally speaking a mixture of Thornton and Derwent water and sometimes there is also a little Cropston water in this supply.

B.—Mixture of Derwent and Cropston water.

C.—Sometimes pure Derwent water and sometimes it has a little Cropston water in it.

	A	B	C
Chlorine ... ..	1·20	1·11	1·10
Ammonia ... ..	·0012	0·0011	0·0009
Albuminoid ammonia ...	0·0187	0·0169	0·0149
Oxygen ... ..	0·0761	0·0705	0·0679
Solids ... ..	14·8	11·9	11·5
Hardness ... ..	4·82	3·39	3·11

By E. Frankland. 24th September, 1898. Filtered water at :—

- 1.—Swithland Waterworks.
- 2.—Bradgate Waterworks.
- 3.—Thornton Waterworks.

	Parts per 100,000		
	1	2	3
Total solids ... ..	30·32	21·88	27·18
Organic carbon ... ..	0·604	0·460	·322
Organic nitrogen ... ..	0·043	0·038	0·034
Ammonia ... ..	0·002	0·002	0·001
Nitrogen as nitrates and nitrites ... ..	0·014	0·011	0·012
Total combined nitrogen ...	0·059	0·051	0·047
Chlorine ... ..	1·9	1·6	1·5
Hardness: Temporary ...	7·6	4·2	6·6
Permanent ... ..	11·5	8·4	12·0
Total ... ..	19·1	12·6	18·6

*History of Water Supply.*—Leicester originated on the river-gravel terrace: the gravel provided a dry site with water readily obtainable by means of shallow wells. The bulk of the supply was drawn from numerous public draw-wells, one of which, called Plancke or Kancke Well, was situated near the top of the present Cank Street.

<sup>1</sup> Communicated by G. T. Edwards, M.Inst.C.E., Engineer and Manager, Leicester Corporation Water Works.

In 1685—so says Nichols<sup>1</sup>—Laurence Carter obtained from the Corporation a lease of the Castle Mill and permission to pump water from the River Soar to cisterns to be constructed by him within the High Cross and to lay pipes therefrom to certain places in the town. Nichols says that the works were completed at a cost of £4,000.

In 1692 the Corporation completed an undertaking by which water from a spring from gravel associated with Boulder Clay in St. Margaret's Field near the top of the present Conduit Street<sup>2</sup> was brought through a leaden pipe to a point in the Market Place nearly opposite the end of what is now called Victoria Parade, where a small octagonal building known as 'The Conduit' covered the leaden cistern in which the water was stored.

From the preceding remarks it will have been gathered that a permanent supply of suitable water for the supply of Leicester could not be obtained within or near the city by means of boreholes: the natural recharge of the Lower Keuper Sandstone, owing to the distance of its outcrop, would be unlikely to be equal to the quantity of water pumped with the result that the supply would diminish—the strata would be over-pumped. Although this aspect of the matter may not have been fully appreciated at the time, the Water Company, which was formed in 1847, resorted to what would still be the only means of obtaining a fair quantity of water locally, namely, impounding a brook.

In 1854 the Water Company completed the Thornton Reservoir in which was impounded the available drainage of 2,860 acres.

In 1870 the Company completed the Bradgate Reservoir in which was impounded the available drainage of 4,400 acres.

In 1878 the Corporation purchased the Waterworks.

On the 18th June, 1881, Mr. Hawksley recommended "That the capabilities of the New Red Sandstone formation should be carefully investigated," and on 27th August, 1881, reported "That the areas of drift and sandstone lying to the north-west of Leicester have not been so sufficiently explored as to enable a sound opinion to be formed of the relative advantages, if any, which they may present as sources of additional supply." The districts to the west of Leicester were examined and samples of water were obtained and submitted for analyses in February, 1882. As a result of a conference the following sources were put on the list for further consideration:—Lingdale Brook, Swithland Brook, Hall Gates Brook, Chilcote Spring, Donisthorpe Colliery, Saddington Reservoir, Ellistown Colliery, and Naseby Reservoir.

Mr. Hawksley was also consulted as to the probability of obtaining a supply from the Triassic sandstones near to Leicester which had been proved by boring on the Evington Estate, but, after having a Report (11th March, 1882) from J. W. Harrison, Mr. Hawksley reported (16th April): "... any water procured by the proposed boring would be so loaded with calcareous and also possibly with soda salts as to be unfit for a domestic and manufacturing supply."

The Committee instructed that further samples of water be obtained for analyses from the neighbourhood of Stretton-en-le-Field and Chilcote. Samples of water were also taken from Snarestone Spinney and the borehole<sup>3</sup> and submitted to Dr. Tidy on the 23rd December, 1882. The analyses of these waters revealed that the hardness before boiling was 23 degrees, after, 7·5 degrees. With reference to the water from the Snarestone borehole Dr. Tidy remarked on the 7th February, 1883: "... the water is of most excellent quality and absolutely free from all trace of nitrates. It is a little hard but

<sup>1</sup> 'The History and Antiquities of the County of Leicester,' vol. i, pt. 2, 1815, p. 318.

<sup>2</sup> In 1893 the spring was protected by a "small stone dome covered with free-stone, called the 'Old Conduit,' with a date in front, 1602." *Gentleman's Magazine*, 1783, pt. 2, p. 752.

<sup>3</sup> At the present Pumping Station of the Hinckley Urban District Council.



this in no sense detracts from its value as a potable water. I consider it excellently well fitted for the supply of a town." On Mr. Hawksley inspecting this analysis he stated: "I concur except in this, that the water may be too hard for manufacturing and boiler users."

In February, 1883, the Committee consulted Prof. C. Lapworth: they furnished him with the whole of the information obtained up to that time, drew his attention to the fact of water having been found on the Spinney Hill Estate, and supplied him with the analyses of the Snarestone waters. On 16th April, 1883, Prof. Lapworth presented his Report in which he recommended the restriction of the search for water to the Snarestone and Donisthorpe district.

Early in May a conference was arranged with Mr. Hawksley when Prof. Lapworth's report and all information was placed before him to obtain his opinion as to where works should be placed and the manner of carrying them out. Mr. Hawksley visited Leicester on the 21st August, went over the districts of Snarestone, Stretton-en-le-Field, Swebstone, Measham, Appleby Magna, Swithland, Woodhouse Eaves, Lingdale and Bardon Hill, and on the 8th September sent in his report in which he referred to three sources: (A) The sandstone formation west of Leicester; (B) The Bardon Hill Watershed; and (C) The Lingdale Brook adjoining the Bradgate Watershed. In this report, speaking of the Snarestone Borehole water, Mr. Hawksley said: "The water is good, bright, pleasant to the taste and by analyses wholesome, but it is by one-half harder than the existing supplies. After boiling it loses two-thirds of its hardness and it admits of being softened by Clark's process. Under these circumstances I recommend that the Committee give instructions to have the yield of the shafts tested in regard to quantity and quality by regular pumping continued for several months in succession."

The Snarestone shaft and pumps in the shaft were accordingly rented. The pumps were started in 1884, and—except for stoppages for repairs and alterations—were continuously at work to 21st January, 1885. The steady yield per day was 382,000 gallons.

Several samples of water were taken during the period of pumping and it was found that in addition to the objection of hardness in the water there was a large amount of common salt to the gallon. Analyses by Dr. Percy Frankland and Dr. Tidy (1st January, 1885) revealed that the water was undesirable for the supply of a manufacturing town although not unwholesome: the reasons why it was undesirable were the large amounts of sulphates of lime and magnesia, of common salt, and the excessive hardness. The Snarestone works were therefore abandoned.

In 1885 J. B. Everard was appointed by the Corporation to make a detailed report on all available sources for an increased supply of water.

Concerning the sources open to consideration Mr. Everard reported<sup>1</sup>:

"Of underground sources . . . the only two having a reasonable probability of success are in the new red sandstones of the west, and in the Oolites of Rutland to the east; and at this stage of the enquiry these need not further be touched upon.

"For surface sources . . . our attention should first be directed to Charnwood Forest, as being more likely to give the purest water, and also because it is situated almost wholly in the watershed of the Soar.

Of this district—						Acres
The present	Thornton	gathering ground occupies about				2,860
The	"	Bradgate	"	"	"	4,400
The	"	Loughborough	"	"	"	1,020

<sup>1</sup> 'Borough of Leicester. Report on the Water Supply,' 1885, p. 12.

And there remain—	Acres
Hall Gates gathering ground with an area of about ...	480
Ling Dale                   "                   "                   "                   "                   "	1,010
Swithland                   "                   "                   "                   "                   "	2,000
Blackbrook                   "                   "                   "                   "                   "	2,920
Bardon Hill                   "                   "                   "                   "                   "	1,670
Bagworth Moats                   "                   "                   "                   "                   "	840
Grobby Moats                   "                   "                   "                   "                   "	3,060

" This list does not include the small streams round Woodhouse, nor the area between the present Loughborough gathering ground and Blackbrook, nor does it include the area draining into the Gracedieu brook, which in addition to a quantity of colliery water, receives the drainage of the large village of Whitwick together with parts of Thringstone and Coalville.

" The southern part of the watershed of the Soar does not present any very favourable areas, and it is not until Countesthorpe is reached that an area presents itself of about 6,650 acres, which appears to offer a field for further investigation.

Still more to the east there is—	Acres
The Kibworth Brook with an area of ...                   "                   "                   "                   "	3,030
The Billesdon                   "                   "                   "                   "                   "	3,940
The Twyford                   "                   "                   "                   "                   "	3,470
And a small adjoining shed at Marefield of ...                   "                   "                   "	860

" These areas would appear to give a sufficient field for further investigation, but as an offer has been made of the interest of the Grand Union Canal Company in the Naseby gathering ground, at the head of the Avon watershed, this area, containing about 2,260 acres, and the adjoining one south of Welford having the same area will be included.

" With the exception of Naseby and Welford belonging to the Avon, and Bardon Hill belonging to the Trent, all the above-mentioned gathering grounds are in the watershed of the Soar."

As regards the quality of the water (see p. 137) :—

" The underground supplies, in which the chemical analyses are almost the sole guide, will be first dealt with, beginning with the new red sandstones and conglomerates of the west.

" [Snarestone] These occupy a large area, and undoubtedly formed a proper field for full investigation, as the area contributing to the supply is large, and similar strata in other parts of the country are of great water bearing value.

" Some doubt might be expressed whether the site selected at Snarestone for the main experiments was the most advantageous, as the shaft from which the water was pumped was in direct communication with the coal measures, in which the water is always of doubtful quality ; but samples were taken from so many places in addition to this, scattered over so wide an area, that of the general result there can be little doubt, the average of 21 samples showing the following result :—

Total solids	Magnesia	Common salt	Total hardness
Grains per gall.	Grains per gall.	Grains per gall.	Degrees
36·74	3·64	7·80	26·14

" This result would not justify this source being included in those reserved for final investigation.

" [Rutland] The remaining area in Rutland would embrace a large area to the East of Exton Park, and the analyses of two examples, one being obtained from a spring in Exton Park and the other from a stream formed by the union of several springs, gave the following average result, the water being of great organic purity :—

Total solids	Magnesia	Common salt	Total hardness
Grains per gall.	Grains per gall.	Grains per gall.	Degrees
22·90	0·77	2·24	16·15

"As, however, a pumping station would take the water, after it had been longer exposed to the action of the Limestone strata through which it flowed, than was the case with the above-mentioned samples, it would not be safe to calculate upon a less total of hardness than 18°."

Mr. Everard tabulated the information concerning the surface sources in two tables. In the table on p. 138 of this work is given such information from his two tables as appears to be of general interest. It is necessary, however, to give certain excerpts from his explanatory remarks.

*Bradgate.*—The table on p. 138 "shows that an additional storage capacity of 60,000,000 gallons is required to make the reservoir at Bradgate equal to the gathering ground, and this could apparently be safely obtained by raising the water weir 1 foot 8 inches. . . ."

*Swithland, Hall Gates, and Ling Dale.*—"Hall Gates as a separate source being abandoned, it would naturally be added to the Swithland gathering ground, and it might also be advisable to add Ling Dale, instead of providing a separate Reservoir for this area. . . . The proposal would be to throw a bank across the valley at Buddon Wood. . . ."

*Blackbrook.*—"A very favourable site exists at this place for a Storage Reservoir. . . ."

*Bagworth Moats.*—"The area of this gathering ground is too small at its upper end to be considered as an independent source; . . . it could only be used therefore as an auxiliary to Thornton. To utilize it in this way a tunnel would have to be made under the hill dividing this from the Thornton watershed, of sufficient size to carry all ordinary floods into the Thornton Reservoir.

"Part of the water now flowing down the Bagworth Moats stream is from Ellistown Colliery, and this would have to be conducted past the intake so as to avoid any possible contamination."

*Naseby and Welford.*—"A better way of using this source [Naseby Reservoir of the Grand Union Canal Co.] would be to purchase the Naseby Works, . . . and leave them in their present state (subject only to necessary repair), with a storage capacity of 180,000,000 gallons; then to purchase land south of Welford, where a favourable site for a reservoir occurs, between Sulby Lodge and Naseby Woolleys. There is some doubt about the proposed position being favourable for a bank, as it is said that a purchased site above Sulby Abbey was abandoned by the Canal Company in favour of the site of the present Naseby Reservoir, in consequence of the nature of the ground.

"Assuming this point to be satisfactorily settled, a reservoir to hold 350,000,000 gallons would be required. . . ."

*Rutland Underground Source.*—"The basis of this scheme would be three pumping stations, east of Exton Park. . . ."

After consideration of the sources of supply Mr. Everard says that of the larger schemes left there are:—

1. Swithland, with Hall Gates and Ling Dale;
2. Blackbrook;
3. Naseby with Welford;
4. Twyford and Marefield.

His final recommendations were:—

- 1.—That application be made in the next ensuing session of Parliament for powers to secure the Blackbrook source.



- 2.—That a similar application be made to secure the Ling Dale source.
- 3.—That a similar application be made to secure the Bagworth Moats source, . . .
- 4.—That the weir at Bradgate be raised 1 foot 8 inches . . . partly to provide for the Ling Dale supply.

In 1886 the Corporation tried to obtain the Blackbrook but were defeated by Loughborough.

In 1890 they obtained powers to impound a small stream at Swithland. But whilst these works were being constructed there occurred the dry years of 1892-1895, and Leicester suffered from practically a water famine. The Thornton supply was augmented with water pumped from the Triassic sandstones at Ellistown (which water still flows down the Stanton-under-Bardon Brook into the Thornton Reservoir), and supplies were taken from existing wells in, and specially sunk wells near, the city. As these wells yielded an exceedingly hard and unsuitable water for a town supply their use was discontinued as soon as possible.<sup>1</sup>

In 1896 the Swithland Works were completed, but owing to the continued increase in the population it soon became evident that an increased supply was necessary. Sources situated within a comparatively short distance of Leicester, comprising the watersheds of the River Eye,<sup>2</sup> and the Marefield,<sup>3</sup> Twyford,<sup>4</sup> and Askwell Brooks, were examined, but Sir Edward Frankland reported<sup>5</sup>:

"The inspection [of the drainage basins] . . . only serves to confirm the analytical results [see p. 139] and to show, unmistakably, that the district is quite unfit for the supply of wholesome and useful water. The Marefield Brook is the only water in this district which, after efficient filtration, would be fit for domestic use; but its excessive hardness renders it quite unsuitable for the supply of a manufacturing town."

The Derwent Scheme, apparently first conceived by J. B. Everard in 1885,<sup>6</sup> was therefore agreed upon in 1889<sup>7</sup> and completed in 1912.

<sup>1</sup> Everard, J. B., 'Leicester Corporation. Additional Water Supply,' Report, 1898, p. 4.

<sup>2</sup> The tributary of the River Wreak.

<sup>3</sup> Marefield is 10 miles E. by N. from Leicester.

<sup>4</sup> Twyford village is 9½ miles E.N.E. from Leicester.

<sup>5</sup> Leicester Water Supply. Report. 1893, p. 4.

<sup>6</sup> 'The Utilization of the Upper Waters of the Derbyshire Derwent,' *Trans. Brit. Assoc. Waterworks Eng.*, vol. vii, 1902, p. 214.

<sup>7</sup> Derwent Valley Water Act.

Name of Source	Total solid matter		Organic Purity	Hardness		Remarks
	Spring Water Grains per gallon	In Bulk Grains per gallon		Spring Water Degrees	Probable in bulk Degrees	
Thornton reservoir ...	—	22·60	Good	—	13·2	No analysis of Spring Water
Bradgate reservoir ...	—	19·90	Good	—	9·0	do.
Hall Gates ...	23·70	—	Good	21·2	14·4	From dry weather sample
Ling Dale ...	17·00	—	Good	15·6	11·9	do.
Swithland ...	19·75	—	Passable	17·0	12·6	do.
Blackbrook ...	24·08	—	Good	19·6	13·5	do.
Bardon Hill ...	—	—	Good	—	—	No analysis
Bagworth Moats ...	25·80	—	Passable	22·3	15·0	From dry weather sample
Groby ...	28·90	—	Doubtful	24·9	16·0	do.
Naseby ...	—	15·15	Passable	—	8·7	Average of 5 samples
Welford ...	26·80	—	Passable	25·6	16·1	do.
Countesthorpe ...	30·00	—	Doubtful	19·5	13·7	From dry weather sample
Kibworth Brook ...	38·00	—	Doubtful	25·9	16·3	do.
Billesdon Brook ...	24·80	—	Doubtful	17·6	12·9	do.
Twyford and Marefield ...	31·00	—	Passable	20·2	14·0	do.
Underground Sources						
Snarestone ...	36·74	—	Good	26·1	26·1	Average of 21 samples
Rutland ...	22·90	—	Good	16·1	18·0	Average of 2 samples

The waters marked "Passable" are those in which the conditions are such, that with care in dealing with the surroundings, a good water can be obtained; those marked "Doubtful" and those having more than 20 degrees of probable hardness in bulk are regarded as unsuitable for a public supply.

	Area of gathering Ground	O.D. Average Height of Source	Average Rainfall over three consecutive dry years	Quantity available per day for supply	Organic purity of water	Probable hardness in Bulk	Actual Capacity of existing Reservoirs, etc., and suggested Sites for Reservoirs	Estimated capacity of Reservoir
	Acres	Feet	Inches	Gallons		Degrees		Mil. galls.
Thornton ... ..	2,860	550	23·7	1,470,000	Good	13·2	Existing reservoir : 360,000,000 gallons	335
<sup>1</sup> Bradgate ... ..	4,400	500	24·7	2,530,000	Good	9·0	" " 500,000,000	560
Hall Gates Brook ... ..	480	480	24·5	270,000	—	—	—	60
Ling Dale ... ..	1,010	500	25·0	605,000	Good	11·9	Near the Brand (service reservoir)	140
Swithland ... ..	2,000	400	23·5	1,000,000	—	—	—	235
Swithland and Hall Gates	2,480	420	23·7	1,270,000	Passable	13·0	—	295
Swithland, Ling Dale and Hall Gates	3,490	450	24·0	1,870,000	Passable	12·6	Valley at Buddon Wood (storage reservoir)	430
Blackbrook ... ..	2,920	530	25·0	1,850,000	Good	13·5	Blackbrook (storage reservoir)	390
Bardon Hall ... ..	1,670	630	24·5	630,000	Good	—	Near Bardon Hill Station ...	210
Bagworth Moats ... ..	840	550	23·7	430,000	Passable	15·00	—	100
<sup>2</sup> Naseby ... ..	2,260	590	23·7	930,000	Passable	8·7	Existing Naseby Reservoir (Grand Union Canal Co.)	230
<sup>3</sup> Naseby and Welford	4,520	545	23·6	1,630,000	Passable	12·4	—	530
Twyford ... ..	3,470	500	22·5	1,620,000	Passable	14·0	East of road leading from Marefield to Burrow-on-the-Hill (storage reservoir)	390
Twyford and Marefield	4,330	500	22·5	2,020,000	Passable	14·0	(Wells. Pump to reservoir on Burley Hill, north-east of Oakham)	490
Rutland ... ..				? 2,500,000	Good	18·0		

<sup>1</sup> The quantity now [1885] per day is probably from 40,000 to 50,000 gallons less than given above in consequence of the small size of the Reservoir, and will be the same amount in excess of the above quantity of 2,530,000 gallons after the reservoir has been enlarged.

<sup>2</sup> The area in this case was arrived at by deducting the area of Naseby village and part of Cold Ashby, from the area given in Mr. Thomas's Report.

<sup>3</sup> The reservoir in this case makes provision for impounding all the compensation water.



## ANALYSES OF WATERS OF THE RIVER EYE, AND OF THE MAREFIELD, TWYFORD AND ASKWELL BROOKS

By Sir Edward Frankland. Leicester Water Supply: Report. 14th November, 1898. Parts per 100,000

Description	Total solid matters	Organic Carbon	Organic Nitrogen	Ammonia	Nitrogen as Nitrates and Nitrites	Total Combined Nitrogen	Chlorine	Hardness			Remarks
								Temporary	Permanent	Total	
23rd September, 1898—											
Marefield Brook	39.80	0.228	0.044	0.004	0.055	0.102	1.5	16.8	8.0	24.8	Turbid
Brook at Twyford	28.04	0.407	0.078	0.010	0.060	0.146	1.7	15.9	8.0	23.9	Turbid
Askwell Brook ...	79.36	0.308	0.100	0.025	0.046	0.166	1.8	17.8	32.2	50.0	Very turbid
River Eye above Saxby drainage	36.36	0.229	0.043	0.014	0.157	0.212	1.3	17.1	5.6	22.7	Turbid
River Eye above Thorpe Arnold Brook	36.24	0.372	0.049	0.012	0.013	0.072	2.1	14.7	8.3	23.0	Turbid
1st November, 1898:											
Marefield Brook	39.60	0.291	0.032	0.003	0.053	0.087	1.4	17.5	7.9	25.4	Very turbid
Twyford Brook...	45.48	0.477	0.038	0.008	0.064	0.109	1.7	20.3	8.1	28.4	Turbid
River Eye above Thorpe Arnold Brook	45.68	0.755	0.098	0.008	0.317	0.422	2.2	16.4	12.6	29.0	Turbid

## ANALYSES MADE IN CONNEXION WITH THE SEARCH FOR WATER FOR LEICESTER

In grains per gallon of 70,000 grains, except Organic Carbon and Nitrogen which are in parts per 100,000.

	Total solid matter	Ammonia	Nitrates and Nitrites as Nitric acid	Oxygen required to oxidize the organic matter	Organic Carbon	Organic Nitrogen	Lime	Magnesia	Sulphuric anhydride	Chlorine (common salt)	Hardness in degrees		Remarks
											Before boiling	After boiling	
1. Bradgate Reservoir ...	10.90	0.005	nil	0.086	0.131	0.020	2.80	1.225	1.21	0.792 = 1.290	10.0	2.85	Silica 0.86 Clear, neutral
2. Thornton Reservoir ...	15.60	0.002	nil	0.111	0.260	0.021	4.14	1.981	1.96	0.756 = 1.239	13.2	3.30	
3. Ellistown Colliery, Aug. 1887 (100 yards down)	33.52	0.002	nil	nil	0.021	0.016	9.85	5.909	5.56	1.512 = 2.478	23.88	10.40	
4. Ditto Aug. 1881 ...	27.00	nil	trace	0.019	0.058	0.026	7.16	2.52	4.75	0.86 = 1.41	13.70	9.5	
5. Ibstock Colliery (80 yards down)	117.2	0.003	nil	0.011	0.036	0.018	8.62	3.495	17.56	52.416 = 85.904	18.10	6.12	Silica 0.56 Clear, blue 31
6. Whitwick Colliery (30 yards down)	41.4	0.003	0.156 = 0.702	nil	0.008	0.002	9.90	7.416	5.72	2.952 = 4.838	32.0	14.76	Silica 0.14 Clear, neutral
7. Swannington (spring)	30.48	0.005	0.208 = 0.936	0.008	0.030	0.014	8.78	6.017	4.23	1.512 = 2.478	24.23	10.40	Silica 0.78 Clear, neutral
8. Whitwick Waste Well (30 yards down)	22.22	nil	0.323 = 1.453	0.008	0.021	0.020	7.31	3.81	4.23	1.512 = 2.478	15.8	6.6	Silica 0.88 Clear, neutral
9. Bagworth Colliery (80 yards down)	127.68	nil	nil	nil	0.022	0.018	36.51	8.53	50.23	2.808 = 4.602	88.4	71.0	Silica 0.76 Clear
10. Bradgate and Thornton Reservoir (mixed)	13.30	nil	nil	0.074	—	—	—	—	—	0.72 = 1.2	11.5	3.0	Silica 1.04 Clear

No. 5 is quite out of the question : about 86 grains of common salt. The apparent softening is effected by the carbonate of soda contained in the water in addition to the common salt. Nos. 3, 6, 7. These are all hard waters and are objectionable by reason of the considerable amount of magnesia held in solution. No. 8 is possible although it contains rather too much magnesia. No. 9 is utterly unfit for either domestic or manufacturing purposes

## SUMMARIES OF PARTICULARS OF DEEP BORINGS

1. Knighton Fields Boring (Co-operative Shoe Factory), Clarendon Park. Site marked on 1-inch Geological Survey Map, New Series, Sheet 156,  $1\frac{1}{4}$  mile S. of Leicester Station. Date of sinking, 1892.
2. Lodge Farm Boring, Spinney Hills. Site marked on Geological Survey Map,  $\frac{3}{4}$  mile N.E. of Station. Began March 4th, 1878. Ht. above O.D., 210 ft.
3. Willow Brook Boring, at foot of Spinney Hills, near where Green Lane crosses the brook. Site marked on Geological Survey Map, 1 mile N.E. of Station.
4. Crown Hills Boring, near Evington. Site marked on Geological Survey Map, just under 2 miles E. by 5°S. of Station. 1879-1880.

	1		2		3		4	
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Lower Lias ... ..							+189	1
Rhaetic (including Tea-green Marls) ... ..							16	9
							or more	
Keuper Marl ... ..	+583	0	+635	6	+640	0	525	2
Lower Keuper Sandstone ...	? 39	0	103	4	101	0+	105	8
Silurian or Cambrian (highly inclined)	Shale, blue and black:		Shale, lower down slaty:					
	203	0+	80	3+			163	7+
	825	0	819	1	741	0	1,000	3

1. Complete record in 'Leicester Memoir,' p. 67. Other accounts are given by J. D. Paul, *Trans. Leicester Lit. and Phil. Soc.*, 1893, p. 105, and Montagu Browne, *idem*, p. 199.
2. Complete record in 'Leicester Memoir,' pp. 61-63.
3. Complete record in 'Leicester Memoir,' pp. 60, 61.
4. Complete record in 'Leicester Memoir,' pp. 63-67. See also J. D. Paul, *Trans. Leicester Lit. and Phil. Soc.*, 1884, pp. 83, 84; Montagu Browne, *idem*, 1893, pp. 200, 201, 214; W. J. Harrison *Midland Naturalist*, vol. viii, 1885, pp. 131, 163; 'Thicknesses of Strata' (*Mem. Geol. Surv.*), 1916, p. 83.



## SUMMARY OF PARTICULARS OF CERTAIN WELLS PROVING UPPER KEUPER SANDSTONE

Site	Ht. above O.D.	Superficial deposits	Keuper Marl	Upper Keuper Sandstone	Total depth
	Ft.	Ft.	Ft.	Ft.	Ft.
Bay Street Mills—W. Scott & Sons ... ..	200	12	36	22	70
Bond Street—Fielding, John-son, Ltd.	210	16	30	29	75
" " " "	201	15	35	41	131
Southgate St. " Brewery—W. Everard & Co., Ltd. ...	203	30	—	20	50
Church Gate—W. Gimston & Sons, Ltd. ... ..	183	10	25	35	70
Friday Street—Jessop & Co. (The late) ... ..	206	12	38	20	70
Jewry Wall—W. & J. Legg Ltd. <sup>1</sup> ... ..	208	40	—	40	80
Canning St. (St. Margaret's Works)—Cooper, Corah & Sons ... ..	200	10	48	26	84
London Road—Moore, Eady, & Murcott Goode, Ltd. <sup>2</sup> ...	220	20	25	45	—
Oxford Street—J. E. Pickard, Ltd. ... ..	206	15	25	35	75
Welford Road—Hodges & Sons ... ..	206	10	35	45	90
Wharf Street—Raven & Co., Ltd. ... ..	186	8	25	72	—

*Aylestone Road Gas Works.—*

Boring made in 1877. Sunk and communicated by Messrs. Docwra & Sons. Ht. above O.D., about 180 ft.

'Leicester Memoir,' p. 71.

		Thickness	Depth
		Ft.	Ft.
Alluvial beds	Black soil ... ..	0½	0½
	Loamy clay ... ..	1½	2
	Sandy clay with stones ... ..	2	4
	Red loamy sand ... ..	2	6
	Red clay mixed with rock stones ... ..	3	9
	Greenish sandy clay mixed with rock stones ... ..	2½	11½
Keuper Marl	Light grey rock ... ..	6½	18
	Light grey rock (soft) ... ..	3	21
	Red sandy marl ... ..	22	43
	Hard red rock ... ..	2	45
	Soft red sandy marl ... ..	4	49

*All Saints' Brewery Co., Ltd.—1884.* Ht. above O.D., about 180 ft.  
'Leicester Memoir,' p. 71.

<sup>1</sup> Formerly Rust & Co.

<sup>2</sup> Formerly Davis, Moore & Co.

		Thickness Ft.	Depth Ft.
Dug well	... ..	—	45
Boring :—			
	Red marl	7	52
	Soft blue stone	4	56
	Purple marl and soft marl in layers	9	65
Keuper	Sandstone	2	67
Marl	Soft red marl	3	70
	Soft red sandy marl	15	85
	Red marl and sandstone	9	94
	Red marl and gypsum	13	107

60 ft. of 5-in. tubing top 19½ ft. down.

Water-level 27 ft. down. Yield 2,400 gallons an hour.

*Bond Street (Fielding, Johnson, Ltd.)*<sup>1</sup>—1884. Ht. above O.D., 214  
[? 201] ft.

*Rep. Brit. Assoc. for 1889 (1890)*, p. 74; Montagu Browne, *Trans. Leicester Lit. and Phil. Soc.*, vol. iii, pt. 4, 1893, p. 147; 'Leicester Memoir,' p. 75.

		Thickness Ft.	Depth Ft.
Well (50 ft., diameter 7 ft.) and borehole (diameter, 7 in.) :—			
	Soil	1	1
	Boulder Clay [valley deposit]	14	15
	Marl with two gypsum beds [yielding water]	35	50
[Keuper	{ Upper { Shales with gypsum [marls	16	66
Marl]	{ Keuper { and skerry] ...	14	80
	{ Sandstone	11	91
	{ Shales [marls and skerry] ...		
	Red marl with four gypsum beds [and some] white sandstone [all yielding water]	40	131

Rest-level, 20 ft. down. "Increase of quantity of 200 per cent. entirely from the boring" (*Rep. Brit. Assoc.*). Water very hard from carbonate and sulphate of lime.

*Canning Street, St. Margaret's Works (Cooper, Corah and Sons)*.—1876. Ht. above O.D., about 174 ft.

*Rep. Brit. Assoc. for 1880 (1881)*, pp. 105, 106; 'Leicester Memoir,' p. 77.

	Thickness Ft.	Depth Ft.
Well (26 ft., diameter, 3½ ft.) and boring (58 ft., diameter, 4 in.) :—		

Gravel and soil	10	10
Marl	48	58
Layers of hard and soft sandstone	26	84
(Running sand at the bottom).		

Water stands at 72 ft., 6 ft. below neighbouring canal.

*Charnwood Street (Leicester Brewing & Malting Co., Ltd.)*<sup>2</sup>.—In yard of brewery. Ht. above O.D., 203 ft.

<sup>1</sup> Formerly Fielding, Johnson & Co.

<sup>2</sup> Formerly F. Bates & Sons' Brewery.

Details of the well given in *Rep. Brit. Assoc.* for 1878 (1879), p. 387, and 'Leicester Memoir,' p. 76; of the borehole, made in 1895, in 'Leicester Memoir,' p. 69.

Well (60 ft., diameter 6 ft.) :—						Thickness		Depth	
						Ft.	In.	Ft.	In.
Drift ... ..						8	0	8	0
Marl ... ..						51	0	59	0
Borehole :—									
Red marl ... ..						10	6	69	6
Hard red and grey rock ... ..						4	0	73	6
Hard red rock ... ..						7	3	80	9
Stone ... ..						4	6	85	3
Red stone ... ..						3	0	88	3
Red marl stone ... ..						13	9	102	0
Blue shale and stone ... ..						3	6	105	6
Green rock ... ..						6	0	111	6
Blue rock ... ..						2	6	114	0
Green stone ... ..						3	6	117	6
Greyish stone ... ..						1	6	119	0
Very hard rock ... ..						4	7	123	7
Green and red shale and rock ... ..						2	9	126	4
Red sandstone and shale ... ..						3	0	129	4
Red sandstone ... ..						7	6	136	10
Sandstone ... ..						22	6	159	4
Red sandstone ... ..						3	0	162	4
Red stone ... ..						3	0	165	4
Red sandstone ... ..						3	6	168	10
Red stone ... ..						5	0	173	10
Sandstone ... ..						3	2	177	0
Red rock ... ..						11	6	188	6
Hard stone ... ..						11	6	200	0

Original Well : rest-level, 30ft. down ; fell to 52 ft. down by continuous pumping but recovered quickly after pumping.

Well and borehole : rest-level 36 ft. down ; supply two barrels a minute.

*Church Gate (W. Gimson and Sons, Ltd.)*.—Near St. Margaret's Church. Ht. above O.D., 183 ft.

*Rep. Brit. Assoc.* for 1878 (1879), p. 388. Ht. above O.D., 183 ft.

						Thickness	Depth
						Ft.	Ft.
Gravel, sand and clay ... ..						10	10
Marls ... ..						25	35
[Keuper Marl]	{	Upper Keuper Sandstone [according to					
		'Leicester Memoir,' 1903, p. 76—					
		"Hard blue rock stone"] ... ..				35	70

Water-levels : standing, 15 ft. down ; after pumping, 35 ft. down (recovers in 8 hours).

*East Park Road (Greenless & Sons, Ltd.)*.—At new factory. Information from W. Keay.

						Thickness		Depth	
						Ft.		Ft.	
Soil ... ..						0 $\frac{3}{4}$		0 $\frac{3}{4}$	
Alluvial deposit with numerous sand pockets ... ..						6		6 $\frac{3}{4}$	
Grey clay (? grey shales in Keuper Marl) ... ..						4		10 $\frac{3}{4}$	
Hard red Keuper Marl ... ..						1		11 $\frac{3}{4}$	

Not much water found in foundation but said to be water-logged in winter.



*East Street : Leicester Pure Ice and Cold Storage Co.*<sup>1</sup>—Boring made in 1927 by Airpumps Ltd., London, and particulars communicated by Messrs. Fossebrooke & Bedingfield, Architects, Leicester. Ht. above O.D., 230·46 ft.

						Thickness Ft.	Depth Ft.
Borehole (diameter, 10 in.) :—							
Keuper Marl	{	Red marl ... ..	...	...	...	112	112
		' Lias ' band ... ..	...	...	...	5	117
		Blue marl ... ..	...	...	...	4	121
		Red marl ... ..	...	...	...	4	125
		Red sandy marl ... ..	...	...	...	10	135
		Hard red marl ... ..	...	...	...	15	150
		Ditto with gypsum bands ... ..	...	...	...	22	172
		Red marl ... ..	...	...	...	38	210
		Soft red marl ... ..	...	...	...	39	249

Some water in soft red marl between 210 and 211 ft. down and between 117 and 122 ft. down.

Water-level (standing), 60 ft. down. Yield about 800 gallons per hour.

*Loseby Lane (The late Messrs. Else & Frome).*—Boring made in 1884 by, and information from Messrs. Le Grand, Sutcliff & Gell, Ltd.

' Leicester Memoir,' p. 70.

						Thickness Ft.	Depth Ft.
Dug well ... ..							
Keuper Marl	{	Red and grey marl ... ..	...	...	...	6	56
		Hard shaly marl ... ..	...	...	...	17	73
		Hard blue marlstone ... ..	...	...	...	9½	82½
		Blue marl rock ... ..	...	...	...	3	85½
		Light [coloured] sandstone ... ..	...	...	...	4½	90
		Light [coloured] marl ... ..	...	...	...	5½	95½
		Red marl rock ... ..	...	...	...	14½	110
		Hard red marl and gypsum ... ..	...	...	...	30	140

Lined with 44 ft. of 5-inch tubing, top 29 ft. down.

Water-level 45 ft. down. Yield 900 gallons per hour.

*Friar Lane, County Council Offices.*—Information from W. Keay.

Old well to Dr. Benfield's house, now used as County Council Offices, but left open for drainage purposes :—

Total depth ... ..	47 ft.
Depth to water... ..	41 "

*Leicester Corporation Sewage Pumping Station.*—Excavation for sewage tanks. Communicated by J. Shardlow per W. Keay. 1927.

				Thickness Ft.	Depth Ft.
Upper Keuper	{	Clay drift ... ..	...	8	8
		Gravel ... ..	...	6	14
		Green shale ... ..	...	16	30

Quantity of water pumped continuously per 24 hours with duplicate electric plant—1,250,000 gallons. Total head 35 ft.

*London Road (Moore, Eady & Murcott Goode, Ltd.).*—Sunk and communicated by Messrs. C. Isler & Co., Ltd.

' Leicester Memoir,' p. 68.

<sup>1</sup> Behind Daimler House.

Shaft, 46 ft., rest bored :—						Thickness		Depth	
						Ft.	In.	Ft.	In.
Keuper Marl	Red marl	...	...	...	...	53	0	53	0
	Hard grey stone	...	...	...	...	4	0	57	0
	Hard red marl	...	...	...	...	20	6	77	6
	Red marl and grey stone	...	...	...	...	7	6	85	0
	Coloured marl	...	...	...	...	4	0	89	0
	Blue marl	...	...	...	...	3	0	92	0
	Rock	...	...	...	...	10	11	102	11
	Red marl...	...	...	...	...	2	0	104	11
	Rock	...	...	...	...	5	0	109	11
	Rock and marl	...	...	...	...	6	0	115	11
	Gypsum and marl	...	...	...	...	7	6	123	5
	Gypsum	...	...	...	...	3	0	126	5

Water-level 29 ft. down. Supply abundant.

As C. Fox-Strangways remarks, the account given of a boring at this place by James Plant, *Rep. Brit. Assoc.* for 1889 (1890), p. 75 (reproduced below), does not agree very well with the above record.

Ht. above O.D., 209 ft.

*Rep. Brit. Assoc.*, 1889, p. 75; Montagu Browne, *Trans. Leicester Lit. and Phil. Soc.*, vol. iii, pt. 4, 1893, p. 153; 'Leicester Memoir,' p. 77.

Well (70 ft., diameter 6 ft.) and boring (80 ft., diameter 6 in.) :—						Thickness		Depth	
						Ft.		Ft.	
Drift						20		20	
Marl with gypsum beds						25		45	
Sandstone and shales [Upper Keuper Sandstone]						45		90	
Red marl with gypsum beds, and thin beds of sandstone						60		150	

Water-level (standing), 20 ft. down.

*London Road, Freemasons' Hall.*—Information from W. Keay. 1910. Sunk below basement floor level to drain away water from ducts, etc. Ht. above O.D., 239·62 ft.

						Thickness		Depth	
						Ft.	In.	Ft.	In.
Keuper Marl	Old sump: no record of strata					10	6	10	6
	Tea-green Marls from which water dripped					11	8	22	2
	Red marl, hard; had to be blasted...					37	4	59	6
	Grey and skerry band					0	2	59	8
	Hard red chocolate coloured marl, very dry; had to be blasted					13	4	73	0
	Gypsum, very hard, compact and solid, no joints					4	0	77	0
	Fibrous gypsum					0	1	77	1
	Hard, green, skerry band					0	3	77	4
	Gypsum and red marl mixed; the gypsum was honeycombed and jointed					4	6	81	10
	Borehole (diameter 3 in.) :—								
	Red marl					11	8	93	6

November 8th, 1910, water 10 ft. deep

December 7th, 1910 „ 14 ft. „

„ 17th, 1910 „ 15·6 ft. deep.

*New Walk, Museum.*—Information from W. Keay. Ht. above O.D., about 231 ft. Well sunk, March, 1911, to drain away water from the basement.

Well (70 ft.) and borehole (3-inch, 4½ ft.) :—

Boulder Clay	Thin	...	...	...	...	...	...
Keuper Marl	{ Hard red marl, devoid of gypsum, which had to be blown ... .. }						74½ ft.

A large quantity of water was met with in the bottom of the well and a steam pump was used to remove same.

On April 12th, 1911, the Clerk of Works reported that the depth of water in the well was 15 ft., and that this depth had remained constant since March.

During the past three years (from 1927) this well has failed to fulfil its purpose. The water rises in the well and floods the heating chamber. The well has been pumped out by a fire engine on two or three occasions, but makes up again after rain.

*Oxford Street (J. E. Pickard Ltd.).*—Information concerning (1) the 'old' well (to 75 ft.<sup>1</sup>) is given in *Rep. Brit. Assoc.* for 1875 (1876), p. 135, and 'Leicester Memoir,' p. 75, and (2) the new boring (1916) has been communicated by Mr. Pickard per W. Keay. Ht. above O.D., 206 ft.

		Thickness		Depth	
		Ft.	In.	Ft.	In.
Well (diameter, 8 ft.) :—					
	Drift [valley deposit]	...	...	15	0
Keuper Marl	Red marl	...	...	25	0
	[Upper Keuper Sandstone] Sandstone	...	...	30	7
	[? marl and skerry]	...	...	70	7
	(From the bottom of this 'old' well an 'old' 4-inch boring, 82½ ft. deep (uncased) was made apparently some time after the well was sunk. A new chisel boring, 6-in. in diameter (cased) was made in June, 1916, and pierced :—				
	Red marl and skerries	...	...	79	5
	Marl [? skerry]	...	...	2	6
	Good sandstone [probably a fine skerry]	...	...	7	0
	[? Marl]	...	...	4	6
	Sandstone, hard	...	...	164	0

Rest-level, about 30 ft. down.

According to Mr. Pickard the 'old' well and 'old' boring yielded 18,000 gallons a day regularly and the surface was never lowered more than 15 or 16 feet; in *Rep. Brit. Assoc.* for 1875 it is stated that the well—which had not then a bore from the bottom—was "emptied in 10 hours, restored in a night." The new (1916) boring has not increased the supply; "indeed the water [from the borehole] could be emptied by the sludge pump. Apparently the supply had been cut off by the lining which was not perforated."

#### ANALYSIS

March 8, 1905.

	Grains per gallon
Chlorine	2.91
Combined carbonic anhydride	4.866
Sulphuric anhydride	74.603
Nitric anhydride	1.36
Sodium oxide	5.683
Calcium oxide	39.48
Magnesium oxide	11.90
Silica	1.40
Iron and alumina	present

<sup>1</sup> Mr. Pickard gave the depth of the old well as 70 ft. 7 in.



These constituents were probably combined to form :—

	Grains per gallon
Sodium chloride ... ..	4.797
Sodium nitrate ... ..	2.14
Sodium sulphate ... ..	5.41
Calcium carbonate ... ..	11.06
Calcium sulphate ... ..	80.83
Magnesium sulphate ... ..	36.00
Silica ... ..	1.4

Hardness (degrees of Clark's Scale) :—

Temporary ... ..	10.0
Permanent ... ..	87.5
Total ... ..	97.5

*Charles Street (The late J. S. Raworth).—1890.*

	Thickness	Depth
	Ft.	Ft.
Dug well ... ..	25	25
Grey marl ... ..	5	30
Red marl ... ..	15	45
Black marl ... ..	2	47
Red marl ... ..	21	68

20 ft. of 4-inch tubing, top 20 ft. down. Water-level 10 ft. down. Yield 24 gallons an hour (lowers water  $7\frac{1}{2}$  ft.).

*St. Mary's Mills (Messrs. W. & A. Bates).—Information from W. Keay. 1920.* Adjoining existing new boiler house over weir.

Excavation to bottom of existing abutment to arches :—

Stiff grey clay ... ..	$3\frac{1}{2}$ ft.
Gravel.	

The surface of the gravel below the towing-path is 11 ft. 3 in. deep. The gravel was tested with an iron bar to the depth of about 1 ft.

*Soar Lane Mills (W. & A. Evans, Ltd.).—Information from W. Keay. 1913.*

Excavation to pier at south-east corner of 'Conditioner' near engine-house.

	Thickness	Depth
	Ft.	Ft.
[Alluvium] Granite paving.		
Fine silty mud, dry, and stands well	$11\frac{3}{4}$	$11\frac{3}{4}$
[River { Gravel ... ..	$0\frac{1}{4}$	12
Fine sand ... ..	$1\frac{1}{2}$	$13\frac{1}{2}$
[Terrace] { Gravel ... ..	$0\frac{1}{2}$	14
Fine sand and gravel ... ..	$3\frac{3}{4}$	$17\frac{3}{4}$
[Keuper Marl] Hard red and grey marl ... ..		

Two hand pumps were required to keep down the water.

*Southgate Street Brewery (W. Everard and Co., Ltd.).—Ht. above O.D., 203 ft.*

*Rep. Brit. Assoc. for 1875 (1876), p. 135 ; 'Leicester Memoir,' p. 76.*

	Thickness	Depth
	Ft.	Ft.
Well (diameter, 7 ft.) :—		
Drift (clay, etc.) [made ground] ... ..	30	30
Upper Keuper Sandstone [? marl and skerry sandstone] ... ..	20	50

Water stands at 15 to 20 ft. down.

*Castle Street Brewery (W. Everard and Co., Ltd.)*<sup>1</sup>—Well sunk in 1885, 45 ft. distant from the preceding well.

Browne, Montagu, *Trans. Leicester Lit. and Phil. Soc.*, vol. iii, pt. 4, 1893, p. 145; 'Leicester Memoir,' p. 83.

		Thickness	Depth
		Ft.	Ft.
Cellar below roadway	...	10	10
Pump pit, stated to be excavated in 'the ordinary town filling'	...	11	21
Borehole :—			
Keuper Marl	Red marls	10	31
	Indurated red marls	29	60
	Red marls and grey marls in layers, with harder 'skerries'	5	65
	Indurated grey marls and sandstone with grey marly partings ('skerries')	9	74
	Grey marl	3	77
	Red marl	14	91
	Red and grey marls with 'skerries' and a little gypsum	13	104
	Red and grey marls with gypsum, apparently in considerable quantity	42	146
	Reddish chocolate and grey, sandy, much indurated marls, with stainings of manganese	4	150

Lined with 50 ft. of 5-in. tube, top 22 ft. 3 in. down.

Water-level, 29 ft. 7 in. down. Yield, 2,000 gallons per hour.

*Vestry Street Baths.*—Made, and information from, Messrs. Le Grand, Sutcliffe and Gell, Ltd. 1890. Ht. above O.D., 184.7 ft. Published in the 'Leicester Memoir,' p. 68. A slightly different account is given by J. D. Paul, *Trans. Leicester Lit. and Phil. Soc.*, 1891, p. 408, and by Montagu Browne, *idem*, 1893, p. 152.

		Thickness	Depth
		Ft.	Ft.
Keuper Marl	Basement floor below surface	10	10
	Dug well	30	40
	Red marl	18	58
	Block marl	15	73
	Red marl	4	77
	Blue stone and clay [skerry sandstone and grey marl] <sup>2</sup>	3	80
	Red marl and gypsum [white sandstone]	14	94
	Red marl	7 $\frac{3}{4}$	101 $\frac{3}{4}$
	Red and blue stone	1 $\frac{3}{4}$	103 $\frac{1}{2}$
	Gypsum	0 $\frac{1}{2}$	104
	Mixture of marl and gypsum	61	165
	Blue stone [mottled grey marl]	2 $\frac{1}{2}$	167 $\frac{1}{2}$
	Red marl	41 $\frac{1}{2}$	209
	Gypsum	1	210
	Red marl	—	—

20 ft. of 7 $\frac{1}{4}$  inch tubing, top 28 ft. down.

Water-level 17 ft. down.

Yield 60 gallons per hour (lowers water-level 17 ft.).

<sup>1</sup> The same brewery.

<sup>2</sup> The additions in square brackets are from observation of the specimens.

*Victoria Leather Works (Briggs & Co., Ltd.).—*

	Thickness	Depth
	Ft.	Ft.
Made ground	5	5
Red marl	55	60
Marl and gypsum	14	74
Sandstone	0½	74½
Marl and gypsum	6	80½
Sandstone	0½	81
Marl and gypsum	28	109
Grey marl	10	119
Marl and gypsum	12	131
Grey sandstone	1½	132½
Marl and gypsum	14	146½
Grey sandstone	1½	148
Marl and gypsum	94	242
Grey sandstone	3	245
Marl and gypsum	32	277
Granite and gypsum	3	280
Marl and gypsum	9	289

51 ft. of 7-inch tubes from 2 ft. down. Water-level (standing) 58 ft. down.  
Yield 80 galls. an hour.

Boring by, and information from, Messrs. Le Grand, Sutcliffe & Gell, Ltd.

*Vulcan Street (Grimson & Co., Ltd.).—*Ht. above O.D., 212 ft.

*Rep. Brit. Assoc. for 1878 (1879), p. 387 ; ' Leicester Memoir, p. 76.*

Well (diameter, 6 ft.) :—	Thickness	Depth
	Ft.	Ft.
Drift [P] ...	6	6
Keuper Marl ...	58	64

Rest-level, 30 ft. down, lowered to 50 ft. down by continuous pumping.

*Wharf Street (Raven & Co., Ltd.).—*1887. Ht. above O.D., 186 ft.

' Leicester Memoir,' pp. 77, 78 (Mr. Plant's MSS. notes, which are given in italics, differ considerably from the correlation published) ; Plant, J., *Rep. Brit. Assoc.*, 1889, p. 75 ; Browne, Montagu, *Trans. Leicester Lit. and Phil. Soc.*, vol. iii, pt. 4, 1893, p. 152.

Boring (120 ft. 7 in. diameter ; 84 ft. 6 in. diameter) :—	Thickness	Depth
	Ft.	Ft.
Drift. <sup>1</sup> <i>Below the level of Wharf Street</i> ...	8	8
Marls. <i>Marl, 10 feet, chocolate marl, 15 feet</i> ...	25	33
Sandstone A. <i>White sandstone, 59 feet</i> ...	30	63
Middle sandstone B ...	20	83
Lower shaly sandstone C ...	22	105
Red marl with gypsum bands. <i>Marly beds with gypsum, 79 feet</i> ...	69	174
Red marls with bands of shaly sandstone. <i>Red marl with bands of sandstone, 33 feet</i> ...	30	204

Communicated by Messrs. Le Grand, Sutcliffe & Gell, Ltd. (to L.R., 24.6.'26)

45 ft. of 7½-inch tubing, top 2 ft. down. Water-level 7½ ft. down. Yield 1,200 gallons per hour.

<sup>1</sup> ' The Drift ' is probably hypothetical. The boring appears to have commenced in the basement at a depth of 8 feet below the street.



## VI.—BIBLIOGRAPHY

## I.—GEOLOGICAL SURVEY PUBLICATIONS

## Maps

## ONE-INCH MAPS. OLD SERIES

Scale : 1 inch=1 mile. 1 : 63360

- 53 N.E. Small part of extreme southern portion of the county in which are Shawell, Catthorpe, Swinford, and South Kilworth.
- 63 N.W. Replaced by New Series Maps.
- 63 N.E. Replaced by New Series Maps.
- 63 S.W. Replaced by New Series Maps.
- 63 S.E. Lutterworth, Market Harborough. (1859, Revised 1873).
- 64 Great Bowden, Cranoe, Blaston, Easton Magna, Edmondthorpe, Wymondham—otherwise replaced by New Series Maps so far as Leicestershire is concerned. (1872, with Drift 1877.)
- 70 Garthorpe, Buckminster, Sproxton, Croxton Kerrial, Harston—otherwise replaced by New Series Maps so far as Leicestershire is concerned (1886).
- 71 S.W. Replaced by New Series Maps.
- 71 S.E. Replaced by New Series Maps.

## ONE-INCH MAPS. NEW SERIES

126. (S.E. corner) Bottesford, Merston, Redmile. (Colour printed 1908.)
141. Castle Donington, Ashby-de-la-Zouch, Loughborough. (Colour printed, 1905.)
142. Belvoir, Old Dalby, Quorndon, Melton Mowbray, Stapleford, Stonesby. (Colour printed, 1909.)
143. (Not re-surveyed : see Old Series Maps 70, 64.)
155. Donisthorpe, Measham, Woodhouse, Orton-on-the-Hill, Market Bosworth, Stoke Golding, Huncote, Enderby. (Hand coloured, Solid, 1899 ; colour printed, Drift, 1910.)
156. Mountsorrel, Whissendine (Northamptonshire), Leicester, Tilton, Narborough, Great Glen, Hallaton, Horninghold. (Drift, colour printed, 1903.)
157. (Not re-surveyed. The very small portion of Leicestershire which comes in this sheet in the extreme S.W. corner comes on the Old Series Map 64.)
169. Higham-on-the-Hill, Hinckley, Barwell, Ullesthorpe, Bitteswell, Broughton Astley, Croft. (Colour printed ; Drift, 1922 ; Solid, 1926.)
170. (Not re-surveyed : see Old Series Maps 53 N.E., 63 S.E., 64.)
171. (Not re-surveyed. The very small portion of Leicestershire which comes in this sheet in the extreme N.W. corner comes on the Old Series Map 64.)

## SIX-INCH MAPS

Scale : 6 inches=1 mile. 1 : 10560

With geological lines, uncoloured, price 2/3 each ; coloured, prices on application to the Director General, Ordnance Survey, Southampton.

9 S.W. (Derby 58 S.W.) ; 15 N.E. (Derby 60 N.E.), S.W. (Derby 60 S.W.), S.E. (Derby 60 S.E.) ; 16 N.W., N.E., S.W., \* S.E. ; 22 N.W. (Derby 63 N.W.), N.E. (Derby 22 N.E.), S.E.\* ; 23 N.W., \* N.E., S.W., \* S.E.\* ; 28 N.W., S.W. ; 29 N.E. ; 31 N.W., N.E., S.W., S.E. ; 34 N.W. ; 37 N.W., N.E. ; 41 N.E. ; 42 S.W.

\*Manuscript copies of Solid Geology deposited for public reference in the Library, 28, Jermyn Street, London, S.W.1. Copies of these maps can be supplied at the cost of drawing and colouring the same. Applications should be made to the Director, Geological Survey Office, Jermyn Street, London, S.W.1.

## QUARTER-INCH MAP

Scale : 4 miles = 1 inch. 1 : 253440

*Old Series : printed in colours**Out of print.**Revised and printed in colours*

11. Main part of County.
15. Smaller southern part of County.

## Horizontal Sections

Scale : 6 inches = 1 mile

*(Those marked thus\* have brief Explanations. Price 2d. each)*

- \*46. No. 1. North-west to south-east, from near Repton to Bardon Hill.  
2. From Nailstone Church through Bagworth Colliery, south end of Charnwood Forest, Woodhouse Eaves, Buddon Hill, to Barrow-on-Soar. (1858.) [Old Series Maps 63 N.W., N.E. 71 S.W.] (Vert. Sects., 19, 20.)
- \*48. From . . . Grendon, through Orton-on-the-Hill, Gopsall Park, Heather Mill, near Whitwick Colliery, north end of Charnwood Forest, Garendon Park to Wysall, near Loughborough. (1858.) [Old Series Maps 62 N.E., 63 N.E., N.W., 71 S.E.] (Vert. Sect. 19.)
- \*49. No. 2. From . . near Kingsbury [Warwickshire], across No Man's Heath, the Leicestershire Coalfield, by Moira, . . . (1858.) [Old Series Maps 62 S.E., N.E., 63 S.W., N.W., 71 S.W.] (Vert. Sect. 20.)
- \*52. No. 1. From the Trent at Newton Solney, to Swepestone, crossing the Ashby-de-la-Zouch Coalfield at Newall, Gresley, Moira and Measham Hall. 2. From west to east, by Linton, the Coal Measures of Ashby Woulds and Coleorton Common, and the Cambrian Rocks of the north part of Charnwood Forest. (1858.) [Old Series Maps 62 N.E., 63 N.W., N.E., 71 S.W.] (Vert. Sects., 19, 20.)
122. From Three Shire Stone, through Thrapston to the River Eye west of Melton Mowbray. (1879.) [Old Series Map 64.]
124. From Buddon Wood, across Mount Sorrel, Burrow Hill (Leicestershire) . . . (1887.) [Old Series Maps 63 N.E., 64.]

## Vertical Sections

1 inch = 40 feet.

19. Sections in the Leicestershire (Ashby-de-la-Zouch) Coalfield, Eastern or Coleorton District. 1. Bagworth Colliery. 2. Ibstock Colliery. 3 and 4. Snibston Colliery. 5. Whitwick Colliery. 6. Heather Colliery. 7. Swannington New Colliery. 8. Peggs Green Colliery. 9. Coleorton Colliery. 10. Lount Colliery. 11. Heath End Colliery. 12. Boring at Rough Park Wood. 13. Clay Pit at Woodville; with an explanation of local mineral terms. (1856.) [Old Series Maps 63 N.W., 71 S.W.]. (Horizontal Sects. 46, 48, 52.)
20. Sections in the Leicestershire (Ashby-de-la-Zouch) Coalfield, Western or Moira District. 1. Donisthorpe Colliery. 2. Oakthorpe New Colliery. 3, 4, 5. Moira Colliery. 6. Woodfield Colliery. 7. Granville Colliery. 8. Boring at Old Swadlincote Colliery. 11. Arthcote Colliery. 12. Whitehouse Colliery. 13. New Stanton Colliery; with an explanation of local mineral terms. (1857.) [Old Series Maps, 63 N.W., 71 S.W.]. (Horiz. Sects., 46, 49, 52.)

## Memoirs, 8vo.

*Arranged Chronologically*

## i.—IN EXPLANATION OF OLD SERIES MAPS :

1860. Hull, E.—The Geology of the Leicestershire Coalfield, and the Country around Ashby-de-la-Zouch. (Quarter Sheets, 63 N.W., 71 S.W.)  
 1860. Aveline, W. T. and H. H. Howell.—The Geology of part of Leicestershire. (Quarter Sheet, 63 S.E.) (*Out of print.*)  
 1875. Judd, J.W.—The Geology of Rutland and parts of . . . Leicester . . . (Sheet 64.)  
 1885. Jukes-Browne, A. J.—The Geology of S.W. part of Lincolnshire with parts of Leicestershire and Nottinghamshire. (Sheet 70.)

## ii.—IN EXPLANATION OF NEW SERIES MAPS :

1900. Fox-Strangways, C.—The Geology of the Country between Atherstone and Charnwood Forest. (Sheet 155.)  
 1903. —, —.—The Geology of the Country near Leicester. (Sheet 156.)  
 1905. —, —.—The Geology of the Country between Derby, Burton-on-Trent, Ashby-de-la-Zouch and Loughborough. (Sheet 141.)  
 1907. —, —.—The Geology of the Leicestershire and South Derbyshire Coalfield. (Coalfield Memoir.)  
 1909. Lamplugh, G. W. and others.—The Geology of the Melton Mowbray District and South-east Nottinghamshire. (Sheet 142.)  
 1923. Eastwood, T., and others.—The Geology of the Country around Coventry. (Sheet 169.)
- 
1916. Strahan, [Sir] A. and others.—On the Thicknesses of Strata in the Counties of England and Wales exclusive of rocks older than the Permian.

## 2.—PUBLICATIONS OF THE GENERAL BOARD OF HEALTH (1848-1858), OF THE LOCAL GOVERNMENT ACT OFFICE (1858-1871), OF THE LOCAL GOVERNMENT BOARD (1871-1919), AND OF THE MINISTRY OF HEALTH

1882. BLOXALL, DR.—On an Epidemic of Enteric Fever in the Urban Sanitary District of Melton Mowbray, in connexion with the Sanitary Condition of the Town. *11th Ann. Rep. L.G.B.: Suppl. Rep. M.O.H. for 1881*, pp. 91-99. (Water Supply, p. 92.)  
 1894. WHEATON, DR. S. W.—Report on an outbreak of Diphtheria in the Hinckley Urban and Rural Sanitary Districts. *23rd Ann. Rep. L.G.B.: Suppl. Rep. M.O.H. for 1893-94*, pp. 143-164. (Water Supplies, pp. 143, 156.)  
 1895. FLETCHER, DR.—Report on the Sanitary Circumstances of the Thurmaston Urban District.  
 1915. Return as to Water Undertakings in England and Wales. Folio. *London.*

## 3.—OTHER BOOKS AND PAPERS RELATING TO WATER SUPPLY, ETC.

1740. SHORT, DR. T.—An Essay towards a Natural, Experimental, and Medicinal History of the Principal Mineral Waters of . . . Leicestershire . . . particularly those of Neville Holt . . . etc. 4to. *Sheffield.*  
 1742. —, —.—The Contents, Virtues, and Uses, of Nevil-Holt Spaw-Water, . . . 2nd ed., 1749. 8vo.  
 1765. ANON [Dr. T. Short].—A General Treatise on various Cold Mineral Waters in England, but more particularly those at . . . Neville Holt, etc. 8vo. *London.*



- 1795-1811. NICHOLS, JOHN.—The History and Antiquities of the County of Leicester. (Medicinal Waters at:—Burton Lazars, vol. ii, pt. 1, 1795, p. 269; Nevill Holt, vol. ii, pt. 2, 1798, pp. 726-728; Sapcote, vol. iv, pt. 2, 1811, pp. 897, 899.) Folio. *London*.
1807. PITT, W.—A General View of the Agriculture of the County of Leicester, etc. 8vo. *London*. (Water Supply, p. 10.)
1826. CUBITT, DR. W. R.—An Essay on Bathing; with Remarks on the Efficacy and Employment of the Mineral Water at Ashby-de-la-Zouch and Moira; in which are introduced Several Interesting Cases. pp. i-xii, 13-96. T. Wayte: *Ashby-de-la-Zouch*.
1830. DAUBENY, DR. C. G. B.—Memoir on the occurrence of Iodine and Bromine in Certain Mineral Waters of South Britain. *Phil. Trans.*, vol. cxx, pp. 223-237 (Ashby-de-la-Zouch, pp. 225, 232, 234.)
1833. CONYBEARE, W. D.—On the alleged discovery of Coal at Billesdon. *Phil. Mag.*, ser. 3, vol. iii, p. 112.
1833. HOLDSWORTH, J.—Notice of the Discovery of Coal Measures and of Fossil Fruits at Billesdon Coplow, in Leicestershire. *Phil. Mag.*, ser. 3, vol. iii, p. 76.
1834. DAUBENY, DR. C. G. B.—On Dr. Ure's Paper in *Phil. Trans.* on the Moira Brine Spring, etc. *Phil. Mag.*, ser. 3, vol. vi, p. 321.
1834. URE, DR. A.—Analysis of Moira Brine Spring, near Ashby-de-la-Zouch, Leicestershire; with Researches on the Extraction of Bromine. *Phil. Trans.*, vol. cxxiv, p. 577.
1841. GRANVILLE, DR. A. B.—The Spas of England. Vol. i, Northern Spas. Vol. ii, Midland Spas. 8vo. *London*. (Ashby and Moira, vol. ii, pp. 129-135.)
1848. COWDELL, DR. CHARLES.—Hinckley Mineral Water. 4to. pp. 2.
1849. PATTERSON, DR. MERVYN.—A Medical Guide to the Hinckley Mineral Spring and Baths, with reference to diseases for which they are useful. To which is appended An Historical Sketch of the Town and Neighbourhood. *London*. pp. i, ii, 1-26.
1852. [Guide Book].—The History and Description of Ashby-de-la-Zouch. W. & J. Hextall: *Ashby-de-la-Zouch*. (The Ivanhoe Baths, and Mineral Waters, pp. 109-116.)
1852. MAMMATT, E., and others.—The History and Description of Ashby-de-la-Zouch, with Excursions in the Neighbourhood. Small 8vo. *Ashby and London*.
1853. WHITELEY, REV. H.—History of the Parish of Sapcote . . . p. 13 (Golden Well). *Leicester*.
1863. HULL, E.—A brief sketch of the Triassic Group of Central England; with special reference to its usefulness as a source of water supply. *Proc. Dudley Geol. Soc.*, vol. i, no. 2, pp. 49-55. (Snibston, p. 51.)
1863. WHITE, WILLIAM.—History . . . of Leicester and Rutland . . . 2nd ed. (Mineral Waters: Burton Lazars, p. 844; Gumley, p. 562; Leicester, p. 179; Moira, pp. 440, 441; Neville Holt, p. 579; Sapcote, p. 706.)
1865. HULL, E.—On the New Red Sandstone as a Source of Water Supply for the Central Towns of England. *Quart. Journ. Sci.*, vol. ii, pp. 418-429.
1874. ANON.—Another Discovery of Coal near Leicester. *Colliery Guardian*, vol. xxvii, p. 757.
1874. Reports.—Sixth Report of the Commissioners appointed in 1868 to inquire into the Best Means of Preventing the Pollution of Rivers. The Domestic Water Supply of Great Britain. Folio. *London*. (Bitteswell, pp. 10, 79, 318; Hugglescote, pp. 76, 116, 357; Leicester, pp. 46, 365; Thurmaston, p. 403; Whitwick, p. 73.)
1876. DE RANCE, C. E.—First Report of the Committee appointed for the purpose of investigating the Circulation of the Underground Waters in the Permeable Formations of England, etc. *Rep. Brit. Assoc.*

- for 1875, pp. 118, 135-138. (General; Austy [Anstey], Desford, Elmeſthorpe, Hathern, Hinckley, Humberſtone, Leiſceſter.)
1876. HULL, E.—A ſcheme of Water Supply for Villages, Hamlets, and Country Pariſhes of the Central and Eaſtern Counties. *Quart. Journ. Sci.*, n.s., vol. vi, pp. 304-317; and *Rep. Brit. Assoc.* for 1875, Sections, pp. 249, 250.
1877. ETHERIDGE, R.—Report on the probability of finding Coal under the Eſtate of the Evington Coal Boring Company at Evington, near Leiſceſter. pp. 4. Folio. Privately printed.
1877. PLANT, J.—Report on the Boring for Coal on the Eſtate, near Evington, Leiſceſterſhire, of the Evington Coal Boring Company, Limited. pp. 3. Folio. May 7. Privately printed.
1878. DE RANCE, C. E.—Third Report of the Committee . . . on the Circulation of Underground Waters, etc. *Rep. Brit. Assoc.* for 1878, pp. 61, 62. (Leiſceſter.)
1878. ———. Notes on ſome Triassic Borings. *Trans. Manchester Geol. Soc.*, vol. xv, pp. 90-112. (Holywell, Hinckley; Elmeſthorpe; Lindridge Hall, Deſford; near Deſford; Austy [Anſtey], Hathern; Chilwell [Notts].)
1879. DE RANCE, C. E.—Fourth Report of the Committee . . . on the Circulation of Underground Waters, etc. *Rep. Brit. Assoc.* for 1878, pp. 386-388. (Elliſtown, Glen Parva, Leiſceſter, Newtown Unthank, Ratcliffe.)
1879. PLANT, J.—Report [to the Hinckley Local Board] on the Water Supply for the Town of Hinckley, Leiſceſterſhire, from the Underground Sources of the Triassic Formation. pp. 12. 8vo. *Hinckley*. Privately printed.
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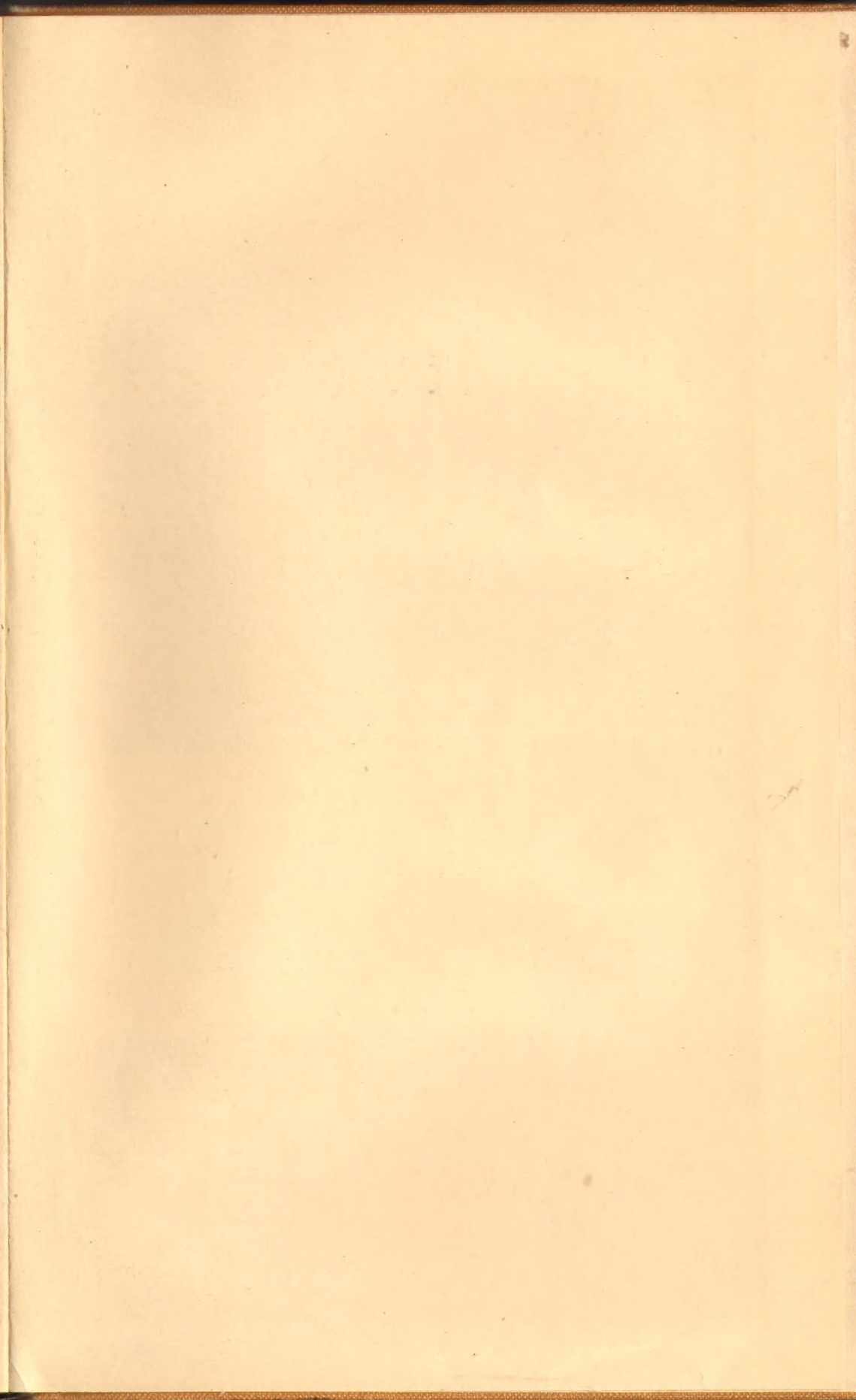
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